Approved for Public Release

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DRAFT NOAA's Mission Requirements Document 2B (MRD-2B) for the GOES-R Series

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Version 1.0, December 13, 2004

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1 Introduction

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1.1 Purpose

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This updated draft version of the Mission Requirements Document (MRD) called MRD-2B draft (MRD-2B to be released in January 2005) was prepared by the NOAA's Satellite, Data, and Information Service (NESDIS) and describes the National Oceanic and Atmospheric Administration's (NOAA's) plan for implementation of the Geosynchronous Operational Environmental Satellite (GOES)-R Series System. The MRD-2B addresses the geosynchronous-earth-orbit (GEO) needs of NOAA, as described in the GOES Program Requirements Document - 1 (GPRD-1) released June 14, 2004. The GPRD-1 reflects NOAA's users needs and updates the Geosynchronous Operational Requirements Document I (GORD-I) released December 2, 2002. The MRD-2B details NOAA's requirements to any acquisition agency. Subsequent lower level documents written by any acquisition agency will reflect NOAA's instrument needs to the vendors.

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The MRD is an evolving document. It was originally released on December 6, 2002 as the MRD-I. It was updated in MRD-1A and was released on July 17, 2003. This MRD-2A was released on March 19, 2004. This MRD-2B will be updated with two more planned versions, MRD-2C and MRD-2D, in approximately the next three years. This current update occurs after the Acquisition and Implementation Phase (formerly Implementation Phase) for the Advanced Baseline Imager (ABI) and after the Broad Agency Announcement (BAA) for the end-to-end GOES Architecture Studies. This MRD also contains updates for the space and solar instrument suites (SIS and SEISS) parameters for the ongoing Preliminary Design and Risk Reduction Phase (formerly the Formulation and Risk Reduction Phase). This MRD reflects NOAA's plans after receiving the results of the BAA and other individual formulation studies and includes existing requirement updates from internal drafts of the updated GPRD. The future MRDs will then provide the updated requirements for the respective Acquisition and Operations (formerly Implementation) Phase of the procurements. The next MRD, MRD-2C, will update the Hyperspectral Environmental Suite (HES) and the Solar Imaging Suite (SIS) and the Space Environmental In-Situ Suite (SEISS) requirements for their Acquisition and Operations Phases nominally in November 2005. The MRD-2D will be released nominally in January 2007, after the final spacecraft and ground trade results. All MRD updates will reflect improved understanding of the appropriate implementation approach that will become apparent through the trade-study processes for the payloads, the spacecraft, and the GOES-R series constellation.

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(Throughout this document, "will" implies a fact, while "shall" implies a requirement. Subsequent versions of the MRD will use shall for all requirements). All instrument requirements contain at least the word (THRESHOLD) and may contain the word GOAL, distinguishing between the necessary and the desirable requirements.

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The GOES-R series represents a significant improvement over the capabilities of both of the current series of GOES satellites. The GOES-R series will meet the more demanding GPRD-1 requirements, unlike the current GOES I and N series. Therefore, more of the weather monitoring and environmental monitoring needs of NOAA will be addressed. The GPRD-1 requirements are reflected in this document and, in the case of the product requirements, are explicitly included in this document (and associated appendix A). The requirements included in the shortfalls section (2.11.3) of this document will not be met in the GOES-R series due to limited resources, whether temporal or financial. The requirements in the pre-planned product improvement (P^3I) section (2.11.4) may not be met in the first satellite(s) in the GOES-R series, but may be met by planned improvements during the GOES-R series.

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The MRD contains threshold and goal performance parameters. The threshold performance parameters represent a starting point for the GOES-R series. If the performance can be improved by making it closer to the goal value by either P^3I or another means, the improvement is desirable from a benefits point of view. The usage of threshold and goal values rather than only goal values is again related to resource limitations.

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319
Requirement parameters in this MRD that differ from those in the GPRD-1 take precedent over those in the GPRD-1 because this document describes the plan for acquisition. Differences can occur when either the GPRD-1 describes a need that will not be completely fulfilled by the anticipated GOES-R launch date or the two documents differ in time. Specifically, the requirements in the MRD may describe a goal value that is reduced compared to that of the GPRD-1. As described above, this may be due to resource limitations. It may also be due to limitations imposed by physics and technology. In each circumstance, if the constraint is not financial, temporal, or due to physics and technology, it is believed there is not a significant impact from these implementation choices.

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1.2 Document Organization

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This MRD contains sections that have previously been called technical requirements documents. These sections and subsections can be separated out to the appropriate agencies at the designated the time. The document has 4 sections: the Introduction that overviews the mission, a Space and Launch Segment

(section 2) and a Ground Segment (section 3) that consists of the following four functional grouping: 3.4) Mission Management (MM); 3.5) Product Generation (PG); 3.6) Product Distribution (PD); 3.7) NESDIS Infrastructure Interface and 4.0) User Interface Segment. Between each of the segments, there will be an interface. The details of each interface will be detailed in separate interface documents not contained in this version of the MRD. The Space and Launch Segment includes the spacecraft, instruments, entire communications payload services located on the spacecraft, on-board processing systems, and launch vehicle. The Space and Launch Segment contains on-board processing systems include feeding the instrument data to the communications system and in parallel feeding the telemetry and command information to the communications system, calibration, and other functions. The Mission Management (MM) functional grouping, includes mission scheduling, satellite (including instrument) operations, satellite state-of-health trending, orbital analysis, and ground operations. The Product Generation (PG) functional grouping includes algorithm support, raw data processing (level 0), processing to level 1b (including calibration, navigation and registration), generation of the data for rebroadcast and for higher level data creation including operational derived products. The Product Distribution (PD) grouping includes distribution of level 1b, GOES rebroadcast data, GOES full data set, and derived products to user portals, addressing interfaces with the user for accessing GOES data. The user portals include the MM (for uplink of GRB and GFUL), NOAA's National Weather Service (NWS), and other users. This section describes hardware, and supports requests from other NOAA line offices. The NESDIS Infrastructure Interface includes the Archive and Access functionality of the Comprehensive Large Array-data Stewardship System (CLASS) system and the implementation details under discussion for that system for storage and retrieval of GOES measurements. The User Interface Segment includes education and training plans for the users to facilitate usage of the larger, richer products sets available from the GOES-R series. Outreach to the general public is also discussed in the section.

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322

1.3 Reference Documents

ID:
323
As mentioned in section 1.1 of this document, this document addresses the geostationary observational requirements of NOAA that will be implemented in the GOES-R series. These geostationary observational requirements are described in the "Program Requirements Document for the Follow-on Geostationary Operational Environmental Satellite System (GOES-R series)", or GPRD-1, released on June 14, 2004. The GPRD will also be updated in the future with subsequent versions (GPRD-1a and GPRD-2) to support reviews within NOAA.

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324
The documents, formerly known as the Technical Requirements Documents for each instrument and any segment, have been incorporated into this document. Thus any numbers in this document supersede those in older documents.

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1.4 Mission

ID:
6021
Program Overview
United States Code Title 15 Chapter 9 has chartered Department of Commerce to forecast weather, issue storm warnings, and display weather and flood signals that will benefit agriculture, commerce, and navigation. National Oceanic and Atmospheric Administration's (NOAA) primary environmental mission is to provide forecasts and warnings for the United States, its territories, adjacent waters and ocean area, for the protection of life and property and the enhancement of the national economy. To achieve this, multiple observation platforms have been developed and are used daily to derive products that are used in protecting estuaries farmlands, endangered species, maritime, air, and ground transportation systems, and property. One observational platform is the NOAA Space-based Observation System, which includes the GOES, Polar-orbiting Operational Environmental Satellites (POES), and the National Polar-orbiting Environmental Satellite System (NPOESS), providing forecasters with short and long term forecast.
The GOES satellites are stationary, located at 75° and 135° W (with potential for movement to 137° W) in GEO. GOES-R satellite will provide capabilities for full disk imagery, with simultaneous (concurrent) Continental United States (CONUS) and Mesoscale environmental imagery and sounding coverage over a large portion of the full disk down to mesoscale regions. This information is used for short term forecasting (as well as longer term forecasting), whereas, the POES and NPOESS satellites orbit the earth in polar LEO orbit, with data revisit every ~4-6 hours in general, providing global observations leading to long term forecast. NOAA's National Weather Service (NWS) uses information derived from both satellite systems to derive additional warning times in cases of major storms and severe events.
The GOES satellites provide an uninterrupted flow of data processed through the ground infrastructure (end-to-end system) to forecasters in the NWS, other international, federal, state, and local governments, universities, and private organizations. These data are processed and assimilated into numerical forecast models that assist in forecasts ranging temporally from daily to extended forecasts, and to severe weather early watches and warnings.

The GOES-R System Mission Operations Center activity includes operations, monitoring, maintaining, acquiring, processing, distributing and storing data from GOES-R satellites. This includes:
- Monitoring satellite health and safety;
- Rapid collection, processing and analysis;
- Scheduling satellite operations and data acquisition to meet GOES-R user needs;
- Evaluating satellite systems performance;
- Commanding the spacecraft;
- Assessing satellite and ground station anomalies;
- Data ingestion, product processing, and distribution of GOES-R data;
- Receiving, compiling, archiving, and disseminating GOES-R data and products out through the GOES users interface.

Planned GOES improvements in the GOES-R timeframe will cross cut NOAA's four mission goals (ecosystems, weather and water, climate, and commerce and transportation). GOES-R will also provide significant enhancement to (when compared to GOES-N products) NOAA's ability to meet the

short-term environmental sensing needs (improved weather event lead-times and more distinct effected areas) by an advancing sensor sensitivity to the detection of atmospheric moisture and improving the understanding of storm development of derived winds, which leads to a more dynamic numerical model performance accuracy. Synergized information will drive earlier predictions, more precise forecast, and precision area to be effected which will support a positive economic impact through dollar savings. GOES-R series acquisition consists of technology advancements in instruments and end-to-end infrastructure. These improvements will benefit the following: imaging and sounding of the atmosphere, sun, and ground environmental parameters; water (streams and rivers) level data collection through the Data Collection Platforms (DCP's); command, control and communications; product generation and distribution and reprocessing, and archive and access, up through the user interface. The GOES-R improvements solidly support NOAA's mission, "to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs."

The GOES-R system provides an observation system that produces reliable data on atmosphere, terrestrial, fresh water, and ocean ecosystems data and will be one of the primary U.S. systems networked into the Global Observing System led by the World Meteorological Organization and that was set as a goal at the Earth Observation Summit (July 2003).

Constraint. Implementation of the advanced ground system capability cannot degrade current capabilities or impede the transmission of information to current users from current satellites.

ID:
6312
Mission Objectives

Primary Mission Objectives

 To maintain GOES mission continuity and quality in environmental observations in the GOES-R timeframe, extending from September 2012 through at least April 2029 (or the equivalent duration if starting later).
  To provide enhanced environmental data products
  To improve services and data being provided to Users
  To be responsive to technology infusion to meet evolving User needs
  To protect, restore, and manage the use of coastal and ocean resources through ecosystem management approaches
  To understand climate variability and change to enhance society's ability to plan and respond
  To serve society's need for weather and water information
  To support the Nation's commerce with information for safe and efficient transportation

Secondary Mission Objective
  To support ties to the NOAA/National/International Observing System

ID:

1.4.1 General Mission Description

ID:
327
The GOES-R series mission will have the following general characteristics that are detailed elsewhere in the document.

ID:
328
Currently, the GOES-R series of satellites shall make observations from geostationary orbit and shall view at least the Western Hemisphere.

ID:
329
The satellite constellation is required to meet the mission availability.

Discussion: Based on initial studies, it is currently anticipated that the approach for the GOES-R series of satellites will be multiple satellites as described in the Government Reference Architecture, or GRA now described in a separate document. The GRA currently reflects an end-to-end system architecture study and government thoughts; subsequent spacecraft trade studies will supply data to make a final determination on this topic.

ID:
330
The satellites shall be controlled from NOAA facilities on the ground.

ID:
331
The instruments supported by the spacecraft shall provide measurements of environmental data and shall provide these data for transmission to ground stations.

ID:
332
Products shall be generated from the calibrated, registered, and navigated data. The products generated from each instrument are detailed in the front of each instrument section of this document.

ID:
333
Products shall be made available to all users.

ID:
334
A subset of the data complete with the calibration, registration, and navigation corrections shall be distributed directly to NOAA-defined users. A subset is being considered because the amount of data

will be higher that the current series due to the larger coverage areas and faster coverage rates. The exact form of the subset is still under review.

ID:
335
The full data set shall also be archived for access by present and future users.

ID:
336
Educational opportunities will exist for users who desire training.

ID:
337
Public outreach plans will be developed.

ID:
338

1.4.2 Mission Schedules and Need Dates

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1.4.3 Mission Requirements Crossing All Segments

ID:
367

1.4.3.1 Maintenance

ID:
368
All maintenance shall be performed with no operational disruption on fulfillment of any requirements.

ID:
369
All segments shall support maintenance of operational interfaces with other applicable GOES R Segments.

ID:
364

1.4.3.2 End-to-End Validation

ID:
365
Each segment shall be validated end-to-end.

ID:
366
The entire GOES-R system shall be validated end-to-end.

ID:
362

1.4.3.3 Mission Security

ID:
363
Mission security shall be maintained for all segments. Mission security deals with satellite operations and transmission production, distribution, and archiving of the GOES-R data.

ID:
6402
Information Technology (IT) Security shall confirm to the NOAA IT standards that can be found at http://www.cio.noaa.gov.

ID:
370

1.4.3.4 Configuration Management and Documentation

ID:

371

ID:
372

1.4.3.4.1.1 Configuration Management

ID:
373
All Segments shall maintain configuration control of hardware, software, and databases.

ID:
374
There shall be an end-to-end GOES-R Configuration Management Plan that will maintain configuration control of interfaces between segments.

ID:
375
Each Configuration Management Plan is subject to Government approval.

ID:
376

1.4.3.4.1.2 Documentation

ID:
377
All Segment hardware and software shall be described in appropriate documentation, including Interface Control Documents (ICDs).

ID:
378

1.4.3.5 Reliability

ID:
379
All Segments as a system shall deliver (TBD) level of reliability. Reliability shall take into account both software and hardware.

ID:
6019

1.4.3.6 Availability

ID:

6020

Mission availability is the probability that the entire GOES-R series system can be successfully used for its specified mission over the stated period of time and is defined as the Mean Time Between Failure (MTBF) divided by the sum of the MTBF and the Mean Time To Repair (MTTR) (nominally uptime divided by the sum of the uptime and downtime).

The mission availability over the operational lifetime shall be 0.82 (TBR). The mission availability on a monthly basis shall be (TBD). The GOES-R series system shall support the data collection, downlink, and creation of GPRD critical user products over CONUS 98% of the time, which is the equivalent of downtime of 0.304 days per month. The system shall support the data collection, downlink, and creation of other GPRD products as the coverage of the system affords.

ID:
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1.4.4 Mission Requirements Crossing Multiple Segments

ID:
381

1.4.5 Mission data latency

ID:
382

Mission data latency from the time the data is collected through the time that the data is converted to a specified GOES-R product (often beyond the level 1b), is product dependent. The data latency varies by product and is recorded with each product in the front portion of each instrument section. However, a common data latency requirement is one minute (TBR) for some ABI products. The most restrictive data latencies in the GPRD-1 are 3 seconds, which applies to the solar X-ray flux, and 30 seconds, which applies for mesoscale (1000 km x 1000 km) cloud and moisture imagery. The 3 second latency requirements shall be divided across the multiple segments in the following way: < 1 sec (TBR) for the Space and Launch Segment, < 1 second (TBR) for the Mission Management functionality of the Ground Segment and existing NOAA facilities including Space Environmental Center in NOAA, and 2 seconds in total for product generation and for Product Distribution functionality of the Ground Segment. The one minute and the 30 second latency requirements shall be divided across the multiple segments in the following ways: for the 30 second requirement- 10 sec (TBR) for the Space and Launch Segment; 1 second (TBR) for the Mission Management functionality; 15 seconds (TBR) for the Product Generation functionality, and 5 seconds for the Product Distribution functionality; and for the 1 minutes requirement-10 seconds (TBR) for the Space and Launch Segment, 10 seconds (TBR) for the Mission Management functionality of the Ground Segment, and 30 seconds (TBR) for the Product Generation functionality and 10 seconds for the Product Distribution functionality.

ID:
383

1.4.6 Mission Lifetime and Reliability

ID:
384
The mission shall provide data and products until the year 2029 (TBS). The mission reliability shall be TBD.

ID:
385

1.4.7 General Mission Observational Requirements

ID:
386
The observational requirements that are met by this MRD are derived from those in the GPRD-1. With the GOES-R series, NOAA has made an effort to address needs beyond the GOES-I and -N series. Imagery and sounding data will be collected with significantly improved spatial and spectral resolution at faster coverage rates over comparable or larger areas. In particular the sounding and imagery rates have been greatly expanded which reduces the conflict between sensing multiple areas of interest in a limited time frame with one instrument.

ID:
387
More complete coverage of weather and environmental events, including sounding through clouds, remains a goal of the GOES-R series to meet the needs of NOAA's NWS. Currently, the instrumentation to do this will be investigated as part of pre-planned product improvement (P^3I) efforts. P^3I efforts are described separately in section 2.11.4.

ID:
388
Monitoring of the short-term variations of the environment will be addressed by GOES-R. Coastal zone coverage at higher spatial resolution is also addressed employing about 0.3 km spatial resolution coverage in dedicated bands in the performance requirements. Many land, aerosol, and ocean products are also new and will be addressed by GOES-R, expanding the capabilities of GOES.

ID:
389
Improvement of solar and space weather sensing to observe solar and space environment variability are planned for GOES-R, with new capabilities under investigation that extend spectral coverage to shorter wavelengths, increase energy measurement ranges, and address the possibility of new measurement types.

ID:
390
The GPRD-1 has divided the remote sensing needs of NOAA into the following categories: atmospheric, land, ocean, and space and solar. The atmospheric category includes the needs of NOAA's

NWS, which contains predominantly the observational requirements from the older NOAA's NWS-Operational Requirements Document (ORD). The Land requirements contain requirements on land surface measurements. The oceans category from the GPRD-1 contains requirements on coasts (including lakes) and oceans. This document includes solar and space requirements in one category called space weather that contains needs for the current Space Environmental Monitoring capability as well as additional solar and energetic particle monitoring in earth's magnetosphere.

ID:
391
The GPRD-1 products, as they exist at the time of writing the MRD-2B, that shall be met by the GOES-R series are listed below. These are not the MRD-2B level requirements but are the inputs to the MRD. The MRD requirements are detailed throughout the text of this document. The GPRD-1 product requirements are recorded for traceability and are listed in the appendix to this document. (It is important to note that all TBD values listed in appendix A are "To Be Determined" jointly by the government and by the contractor. The GOES Program office will be maintaining control over the supplied values. Many of these values will require detailed study over the period of several years to assess the capability of the system, particularly when TBD was used for measurement accuracy values.) Because the product names are inputs to the MRD from the PRD, the user supplied product name has been used. Thus the user supplied term Hemispheric is met by the ABI data from full disk views of the earth (out to the earth's limb for some products including qualitative cloud drift winds and out to about 70 degree local zenith angle (LZA) for more quantitative product) and is addressed by HES out to 62 degree LZA for retrievals (or slightly beyond as radiative transfer models improve). Users are aware that full disk data will be produced from the ABI and that HES data required outside of the 62 degree LZA may require longer than 1 hour to collect at the coverage rate of 62 degree LZA/hour. For emphasis the usage of hemispheric in quotes in applied when the primary instrument for the product is HES.

ID:
392
Within the table below is a partitioning of the products by instrument. Note that the usage of coastal and offshore are included in the definition for coastal used for HES.

ID:
393
Section 2.11.3 discusses any shortfalls in meeting NOAA's needs as described in the GPRD-1 and provided some valuable comments on the products. That section also includes a discussion of any variation between the requirements of the GPRD-1 and the planned implementation, and justification for that implementation. Section 2.11.4 describes P^3I efforts.

ID:
394

1.4.7.1 GPRD-1 Atmosphere

AEROSOLS	
Aerosol Particle Size	ABI
Aerosol Detection: CONUS (including Smoke and Dust)	ABI

Aerosol Detection: Hemispheric (including Smoke and Dust)	ABI
Aerosol Detection: Mesoscale (including Smoke and Dust)	ABI
Dust/Aerosol: Loading: CONUS	HES-DS, ABI must help
Dust/Aerosol: Loading: "Hemispheric"	HES-DS, ABI will help
Suspended Matter: CONUS	ABI
Suspended Matter: "Hemispheric"	ABI
Volcanic Ash	ABI, HES-SW/M must help
CLOUDS	
Aircraft Icing Threat	HES-DS
Cloud Imagery: Coastal	ABI: Day, HES-CW will help: Day ABI: Night
Cloud & Moisture Imagery: CONUS	ABI
Cloud & Moisture Imagery: Hemispheric	ABI
Cloud & Moisture Imagery: Mesoscale	ABI
Cloud Base Height: CONUS	HES-DS
Cloud Base Height: "Hemispheric"	HES-DS
Cloud Base Height: Mesoscale	HES-SW/M
Cloud Ice Water Path: CONUS	ABI
Cloud Ice Water Path: Hemispheric	ABI
Cloud Ice Water Path: Mesoscale	ABI
Cloud Layers/ Heights and Thickness: CONUS	HES-DS and ABI
Cloud Layers/ Heights and Thickness: "Hemispheric"	HES-DS and ABI
Cloud Layers/ Heights and Thickness: Mesoscale	HES-SW/M and ABI
Cloud Liquid Water: CONUS	ABI
Cloud Liquid Water: Hemispheric	ABI
Cloud Liquid Water: Mesoscale	ABI
Cloud Optical Depth: CONUS	ABI
Cloud Optical Depth: Hemispheric	ABI
Cloud Particle Size Distribution: CONUS	ABI and HES-DS helps
Cloud Particle Size Distribution: Hemispheric	ABI and HES-DS helps
Cloud Particle Size Distribution: Mesoscale	ABI and HES-SW/M helps
Cloud Top Phase: CONUS	ABI
Cloud Top Phase: Hemispheric	ABI
Cloud Top Phase: Mesoscale	ABI
Cloud Top Height: CONUS	HES-DS, ABI helps
Cloud Top Height: "Hemispheric"	HES-DS, ABI helps
Cloud Top Height: Mesoscale	HES-SW/M, ABI helps
Cloud Top Pressure: CONUS	HES-DS and ABI
Cloud Top Pressure: "Hemispheric"	HES-DS and ABI
Cloud Top Temperature: Hemispheric	ABI and HES-DS helps
Cloud Top Temperature: Mesoscale	ABI and HES-SW/M helps
Cloud Type: CONUS	ABI and HES-DS helps
Cloud Type: Hemispheric	ABI
Cloud Type: Mesoscale	ABI and HES-SW/M helps
Convective Initiation	ABI and HES-SW/M

Enhanced "V"/Overshooting Top Detection: CONUS	ABI and HES-SW/M helps
Enhanced "V"/Overshooting Top Detection: Mesoscale	ABI and HES-SW/M helps
Hurricane Intensity	ABI
Imagery: All-Weather/Day-Night Hemispheric	ABI contributes
Imagery: All-Weather/Day-Night: Hemispheric	ABI contributes
Lightning Detection: CONUS	GLM
Lightning Detection: Hemispheric	GLM
Lightning Detection: Mesoscale	GLM
Low Cloud and Fog	ABI
Turbulence: Hemispheric	ABI and HES-DS helps
Turbulence: Mesoscale	ABI and HES-SW/M helps
Visibility: Coastal	ABI and HES-CW
Visibility: Hemispheric	ABI
PRECIPITATION	
Removed	Removed
Removed	Removed
Removed	Removed
Removed	Removed
Removed	Removed
Removed	Removed
Probability of Rainfall	ABI
Rainfall Potential	ABI and HES-DS helps
Rainfall Rate/Quantitative Precipitation Estimate	ABI
PROFILES	
Atmospheric Vertical Moisture Profile: CONUS	HES-DS and HES-SW/M helps
Atmospheric Vertical Moisture Profile: "Hemispheric"	HES-DS
Atmospheric Vertical Moisture Profile: Mesoscale	HES-SW/M
Atmospheric Vertical Temperature Profile: CONUS	HES-SW/M
Atmospheric Vertical Temperature Profile: "Hemispheric"	HES-DS
Atmospheric Vertical Temperature Profile: Mesoscale	HES-SW/M
Capping Inversion Information: CONUS	HES-DS
Capping Inversion Information: Mesoscale	HES-SW/M
Derived Stability Indices: CONUS	ABI and HES-DS
Derived Stability Indices: Mesoscale	ABI and HES-SW/M
Moisture Flux: CONUS	HES-DS and HES-SW/M and ABI
Moisture Flux: "Hemispheric"	HES-DS and ABI
Moisture Flux: Mesoscale	HES-SW/M and ABI
Removed	Removed
Pressure Profile: Mesoscale	HES-SW/M helps
Total Precipitable Water: "Hemispheric"	HES-DS
Total Water Content: CONUS	HES-DS
Total Water Content: "Hemispheric"	HES-DS
Total Water Content: Mesoscale	HES-SW/M
RADIANCES	
Clear Sky Masks: CONUS (depends on instrument)	ABI or HES-DS or

	and/or HES-CW
Clear Sky Masks: Hemispheric	ABI or HES-DS
Clear Sky Masks: Mesoscale	ABI or HES-SW/M
Radiances: CONUS	HES-DS
Radiances: "Hemispheric"	HES-DS
Radiances: Mesoscale	HES-SW/M
RADIATION	
Absorbed Shortwave Radiation: Surface/ Hemispheric	ABI makes proxy
Absorbed Shortwave Radiation: Surface/ Mesoscale	ABI makes proxy
Downward Longwave Radiation: Surface/CONUS	ABI and HES make proxy
Downward Longwave Radiation: Surface/Hemispheric	ABI and HES make proxy
Downward Solar Insolation: Surface/ CONUS	ABI, HES helps
Downward Solar Insolation: Surface/ Hemispheric	ABI, HES helps
Downward Solar Insolation: Surface/ Mesoscale	ABI, HES helps
Reflected Solar Insolation: TOA / CONUS	ABI, HES helps
Reflected Solar Insolation: TOA / Hemispheric	ABI, HES helps
Upward Longwave Radiation: Surface/CONUS	HES-DS
Upward Longwave Radiation: Surface/"Hemispheric"	HES-DS
Upward Longwave Radiation: TOA/ CONUS	HES-DS
Upward Longwave Radiation: TOA/ "Hemispheric"	HES-DS
TRACE GASES	
Removed	Removed
CO Concentration	HES-DS
Removed	Removed
Removed	Removed
Removed	Removed
Ozone Total: CONUS	ABI and HES
Ozone Total: "Hemispheric"	ABI and HES
SO$_2$ Detection only	ABI
WINDS	
Derived Motion Winds: CONUS	ABI and HES-DS helps
Derived Motion Winds: Hemispheric	ABI and HES DS-helps
Derived Motion Winds: Mesoscale	ABI and HES-SW/M helps
Microburst Winds	ABI and HES-DS and HES-SW/M helps

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771

1.4.7.2 GPRD-1 Oceans

Currents: Hemispheric	ABI, HES-OO may help
Currents: Mesoscale	ABI, HES-CW
Currents: Offshore / CONUS	ABI, HES-CW,

	HES-OO may help
Removed	Removed
Ocean Color: Coastal (Turbidity/Chlorophyll/ Reflectance)	HES-CW
Ocean Color: CONUS/Offshore (Turbidity/Chlorophyll/ Reflectance)	HES-CW
Ocean Color: Offshore (Turbidity/Chlorophyll/ Reflectance) -- Hemispheric	HES-OO
Ocean Turbidity: "Hemispheric" (Turbidity/Visibility)	HES-OO
Optical Properties: Coastal (particulate absorption, backscatter, fluorescence)	HES-CW
Optical Properties: CONUS/Offshore (particulate absorption, backscatter, fluorescence)	HES-CW
Removed	Removed
Sea & Lake Ice/Age: Hemispheric	ABI primarily, or HES-OO
Sea & Lake Ice/Concentration: CONUS	ABI
Removed	Removed
Sea & Lake Ice/Concentration: Hemispheric	ABI
Removed	Removed
Sea & Lake Ice/ Displacement and Direction: Hemispheric	ABI
Removed	Removed
Removed	Removed
Sea & Lake Ice/Extent and Characterization: Hemispheric	ABI
Sea & Lake Ice/ Motion: CONUS	ABI
Sea & Lake Ice/ Motion: Hemispheric	ABI
Removed	Removed
Removed	Removed
Sea & Lake Ice/Surface Temp: Hemispheric	ABI
Removed	Removed
Sea Surface Temperature: CONUS/Offshore	ABI, HES-CW may help (goal)
Sea Surface Temperature: Hemispheric	ABI
Sea Surface Temperature: Mesoscale	ABI, HES-CW may help (goal)

ID:
851

1.4.7.3 GPRD-1 Land

Fire / Hot Spot Imagery: CONUS	ABI
Fire / Hot Spot Imagery: Hemispheric	ABI
Flood/Standing Water: Hemispheric	ABI, HES-DS, and HES-CW could help
Flood/Standing Water: Mesoscale	ABI, HES-SW/M, and HES-CW could help
Ice Cover/ Landlocked: Hemispheric	ABI

Land Surface (Skin) Temperature: CONUS	ABI and HES-DS helps
Land Surface (Skin) Temperature: Hemispheric	ABI and HES-DS helps
Land Surface (Skin) Temperature: Mesoscale	ABI and HES-DS helps
Removed	Removed
Snow Cover: CONUS	ABI
Snow Cover: Hemispheric	ABI
Snow Cover: Mesoscale	ABI
Snow Depth over Plains: CONUS	ABI
Snow Depth over Plains: Hemispheric	ABI
Snow Depth over Plains: Mesoscale	ABI
Surface Albedo: Hemispheric	ABI
Surface Emissivity	HES-DS, ABI could help
Vegetation Fraction: Green	ABI, HES-CW could help
Vegetation Index: CONUS	ABI, HES-CW could help
Removed	Removed

ID:
913

1.4.7.4 GPRD-1 Space Weather (Space and Solar)

ENERGETIC PARTICLES	
Energetic Heavy Ions	SEISS: EHIS
Magnetospheric Electrons and Protons: Low Energy	SEISS: MPS
Magnetospheric Electrons and Protons: Medium and High Energy	SEISS: MPS
Solar and Galactic Protons	SEISS: SGPS
MAGNETIC FIELD	
Geomagnetic Field	Magnetometer
SOLAR	
Solar Flux: EUV	SIS: EUVS
Solar Flux: X-ray	SIS: XRS
Solar Imagery: X-Ray	SIS: SXI

ID:
948
1.4.6.5 Pre-Planned Product Improvement Products

ID:
949
Pre-Planned Product Improvement (P^3I) products are discussed in section 2.11.4 and listed at the end of that section.

ID:

950

1.4.8 Mission Continuity

ID:
951
The mission shall conform to the NOAA-NESDIS Continuity of Operations Plan (COOP) providing policy, guidance, and procedures that ensure, in the event of emergencies or threat of an emergency, both the preservation of data and continuity of operations.

ID:
952

2 Space and Launch Segment

ID:
953

2.1 Implications of Mission Requirements Crossing All Segments

ID:
954

2.1.1 Mission security in this segment

ID:
955
Mission security will be maintained in the Space and Launch Segment.

ID:
6528

The spacecraft shall be capable of operation with encrypted or unencrypted commands.

Discussion: Normal operations will employ encrypted commands.

ID:
956

2.1.2 End to end validation in this segment

ID:
957
End-to-end validation of each of the instruments shall be performed.

ID:
958
Spacecraft and instruments end-to-end validation tests shall be performed during the pre-launch period to demonstrate full operational capabilities for each phase of the GOES-R mission.

ID:
959

2.1.3 Configuration Management and Documentation

ID:
960
2.1.3.1   Configuration Management

ID:
961
The Segment shall maintain configuration control of hardware, software, and databases.

ID:
962
The Segment Configuration Management Plan shall be developed.

ID:
963
3.1.3.2   Documentation

ID:
964
All Segment hardware and software shall be described in appropriate documentation, including Interface Control Documents (ICDs).

ID:
965

2.1.4 Reliability

ID:
966
The Segment shall deliver (TBD) level of reliability.

ID:
6404

2.1.5 Availability

ID:
6405
Space and Launch Segment availability is the probability that the Space and Launch Segment can be successfully used for any specified mission over the stated period of time and is defined as the Mean Time Between Failure (MTBF) divided by the sum of the MTBF and the Mean Time To Repair (MTTR) (nominally uptime divided by the sum of the uptime and downtime). Planned operations will be scheduled routinely throughout the lifetime of the GOES-R series and will not count against the system availability; these include station-keeping, satellite relocation of up to 30 days, any keep out zone periods, any yaw flips, and housekeeping that includes instrument calibration and momentum management.
The average Space and Launch Segment availability of the Space and Launch Segment over the operational lifetime and over the coverage areas shall be 0.83 (TBR) over the east and west coverage zones. (The east and west coverage zone lie outside of the central coverage zone for either primary instrument located in a central operating position).
The average minimum Space and Launch Segment availability on a monthly basis shall be no smaller than 0.83 (TBR).
The Space and Launch Segment availability for data over CONUS shall be 99 (TBS)%, which is the equivalent downtime of 0.304 days per month. The system shall support the data collection, downlink, and creation of other GPRD products as the coverage of the system affords.

Discussion: The Space and Launch Segment availability is the major contributor to total mission availability.

ID:
967

2.2 Implications of Mission Requirements Crossing Multiple Segments

ID:
968

2.2.1 Data latency in this segment

ID:
969
Data latency between the detection of the earth signal to the initiation of data transmission is TBS.

ID:
970

2.2.2 Maintenance

ID:
971

TBD

ID:
972

2.2.3 Removed

ID:
973
TBD

ID:
974

2.3 Satellites in Constellation

ID:
975

2.3.1 Constellation Description and Definitions

ID:
976
2.3.1.1 GOES-R Space and Launch Segment Architecture

ID:
977
There will be multiple satellites in the GOES constellation. A satellite consists of a spacecraft to hold the instruments, the associated communication systems, and the communications payload services.

Discussion: Several satellite architectures, and thus constellation architectures, are under consideration. Two primary architectures that are being considered are the consolidated architecture and the distributed architecture, although other architectures with other names that meet the requirements of the MRD are not excluded. The consolidated architecture uses two satellites, which is similar to the architecture for the current GOES. A distributed architecture consists of two or more satellites at each operational location, providing the same functions as a single consolidated satellite. The consolidated architecture supplies all payloads in a single satellite whereas the distributed architecture distributes the payloads across several satellites. The Government Reference Architecture is an example architecture; the details are located in a separate document. For reference, the consolidated architecture has the same architecture as the GOES I-P series; the distributed architecture may have more than one satellite at each operational orbital location.

ID:
978
2.3.1.2 Architecture Definitions

ID:
979
The number of operational satellites under normal conditions varies based on architecture type.
If P^{3}I requirements are met through the use of additional satellites, potentially more operational satellites may be present than in the normal operating condition.

ID:
980
The east and west orbital locations are nominally 75- and 135- degrees west longitude respectively. The nominally 137-degree west position is being investigated as a replacement for the 135-degree position due to a possible conflict with another satellite.

ID:
981
If there is a centrally located operational satellite, it will be operated from 105-degrees West (TBS).
Discussion: If an operational satellite is implemented as part of P^{3}I or if there is one unpaired operational satellite with one satellite each for unique capabilities on the east and west positions, the satellite will be located at the central position of nominally 105-degrees West

ID:
982
On-orbit spare satellites (see section 2.4.3), will be nominally stored at the 105-degrees West (TBS) orbital location.   .

Discussion: On-orbit testing prior to operations will be conducted from another central locations, nominally 90 degrees West.

ID:
983
(Removed)

ID:
984
Removed

ID:
985
Removed

ID:
986
Any remaining space in the satellite beyond the allocation for the payloads described in Section 2.10 will be allocated to additional P^{3}I resources.

ID:

987
Removed

ID:
988
Removed

ID:
989

2.3.2 Constellation Restrictions and Requirements

ID:
990
The location of each satellite in the constellations shall be controlled by NOAA ground systems to within +/-0.5 degrees (TBR) in latitude and longitude at the equator; a smaller orbital box size is under study.
Discussion: Tightening of this orbital box listed here is under consideration.

ID:
6350
Discussion: The Space and Launch Segment availability over the system lifetime under various scenarios is shown in the table below. The lowest operational availability, 0.81, occurs when there is only one of one of the primary instruments operating in a back-up mode.

ID:
991

2.3.3 Constellation Failure

ID:
992
A constellation failure is experienced when there is no back-up available whatsoever for a satellite that has a failure. A constellation failure does not occur upon the failure of one satellite if it can be replaced with another satellite of a different type operating in a backup mode. Planned reduced constellation performance will result, which is deemed acceptable by NOAA. A satellite failure may be caused by a hardware or software failure on the satellite that prevents the satellite from fulfilling its mission. A satellite may be deemed a failure as a result of a primary instrument failure, described in section 2.4.3, or a communications failure that does not permit the primary instruments to downlink their sensor data.

ID:
6403
The GOES-R constellation shall not fail before April 2029 (TBS).

ID:

993

2.3.4 Constellation Transition Strategy

ID:
994
The constellation will begin with the launch(es) of a satellite flying an ABI and a satellite flying a HES in a distributed architecture, or a single satellite in the consolidated architecture. After the satellite(s) reach(es) operational status, the GOES-R constellation will have reached Initial Operational Capability (IOC). It is assumed that 6 to 12 months later, either another consolidated satellite or another satellite flying an ABI and another satellite flying a HES will be launched, nominally GOES-S. IOC shall provide either of the west or east coverage exclusively with GOES-R series satellite(s) and associated Ground Segment capabilities. Full Operational Capability (FOC) shall provide the full coverage of the east and west positions and associated Ground Segment. FOC describes the completed capabilities of either a distributed architecture or a consolidated architecture constellation. After a period nominally equivalent to the mean mission duration, there will be another launch(es) of a satellite flying an ABI and a satellite flying a HES. After 6 to 12 months, the next satellite flying an ABI and satellite flying a HES will be launched to provide a full replacement of the constellation. Satellite replacement is discussed in section 2.4.3.

ID:
995

2.3.5 Constellation Success

ID:
996
Final constellation success is achieved after FOC is achieved; satellites are located in their nominal positions, have successfully completed checkout/commissioning, are meeting their operational mission after instrument activation, and are meeting mission availability requirements.

ID:
997

2.4 Satellites

ID:
998

2.4.1 Satellite Lifetime

ID:
999
For a distributed architecture, the satellite (bus plus instruments) shall be designed for at least an 8.25 year Mean Mission Duration (MMD) after 10 years. For a consolidated architecture, the satellite (bus plus instruments) shall be designed for at least a 7 year Mean Mission Duration (MMD) after 10 years.

For another type of architecture, the MMD is TBD after 10 years. The MMD is the integrated area under the reliability versus time curve from t = 5 years to t = 15 years, divided by the reliability estimated at 5 years. MMD applies after all storage (ground and on-orbit) and after launch discussed in section 2.4.3. This operational requirement shall be met after 5 years of ground storage and 5 years on on-orbit storage. The on-orbit storage degradation for the satellites (bus plus instruments) is TBD and must be included to meet the MMD specification.

Discussion: This means that the satellite, including instruments, will provide 10-year satellite on-life with satellite reliability of 0.54 at end of life for the distributed architecture and 0.34 for the consolidated architecture. (On-life simply means that the satellite will be operating for a period of 10 years with a reliability of 0.6 at the 10-year point.) This follows the on-orbit storage time and ground storage time discussed in section 2.4.3. As detailed for the HES and ABI, a 10-year instrument-on life shall be supported with Instrument Reliability (R) of 0.6, based on a satellite Reliability of >/= 0.90 at 10 years.

ID:
1000
Blank

ID:
1001

2.4.2 Satellite Failure

ID:
1002
Replacement of the satellite with a spare shall occur to support the mission availability requirement when one of the primary instruments, namely ABI or HES fails to meet the specified performance required to produce its primary products. All conditions that produce no signal or permit no data transmission on the sensor data downlink and consequently yield indeterminate instrument noise performance also constitute a failure. NOAA will decide if the level of performance for a given instrument is sufficient to continue operation of any satellite beyond the specified lifetime.

ID:
1003

2.4.3 Satellite Replacement Strategy

ID:
1004
To prevent a mission failure, either a spare satellite may be moved into place to provide the needed coverage or an existing operational satellite may be repositioned to provide the needed coverage.

The replacement strategy shall provide a replacement satellite on schedule for its full operational life. If a satellite fails with no on-orbit spare this may result in a period of degraded performance until a replacement satellite is launched. Prior to this launch of the replacement, the system is operating in a degraded mode.

Discussion: The estimated launch queue for a new satellite is as long as a year.

Discussion: Degraded modes are mode 1, which consists of a HES in the central location and an ABI at each of the west and east locations, and mode 2 which consists of an ABI in the central location and a HES at each of the west and east locations.

When not in degraded mode, the locations of the other instruments shall be determined by requirements on their locations.

ID:
1005
Discussion: However, due to the need for ABI data, the failure of satellite flying the ABI will result in a repositioning of the functioning satellite flying the ABI to the nominal 105-degree West position. The remaining satellite(s) in the East and West positions will take over some of the imaging task by using the HES. The HES instrument must be capable of yielding image data at reduced spectral resolution to permit a backup of the ABI capabilities. The failure of a satellite flying the HES will result in a repositioning of the operating satellite flying the HES to the nominal 105-degree West position because the sounding capability cannot be easily backed up with another type of satellite. For any architecture, the repositioning shall be by manual authorization. For any architecture, the repositioning shall be completed in drift rate of 1 degree per day (THRESHOLD) and a drift rate of 10 degrees per day (GOAL).

ID:
1006
Satellite Design

ID:
1007
The satellite shall meet, in conjunction with the related instruments error(s), the product requirement for pointing and mapping as defined for each instrument under section 2.10. The threshold value for orbit determination is that of the GOES-N system. To afford improved product performance however, the goal is to include the goal performance for the product requirements for pointing and mapping.

ID:
1008

2.5 Description of spacecraft Requirements

ID:
1009
The terms spacecraft here applies to the platforms that will contain the instrument payloads and the communications services payloads.

ID:

1010

2.5.1 General Requirements

ID:
1011
Each spacecraft in the GOES-R constellation shall accommodate the appropriate instrument payload for the satellite. The instrument payload accommodation will include allocations, at a minimum, for the mass, power, size, data rate, pointing control and knowledge, and FOVs, as currently defined in the General Interface Requirements Document (GIRD) and the Unique Instrument Interface Requirements Document (UIID) for each instrument.

ID:
1012
The spacecraft shall be capable of operating all the following simultaneously and continuously, including during eclipse: spacecraft subsystems, communication payload services, and instrument payloads in their normal operational modes.

ID:
1013
The spacecraft shall be a 3-axis stabilized, nadir pointing design.

ID:
6531

2.5.1.1 Spacecraft motion

ID:
6527
The spacecraft **shall** be capable of the following 9 station location changes during its on-orbit life.
a. From checkout location to an on-orbit storage location at up to 2° shift/day (TBR)
b. From the on-orbit storage location to the operational station location at up to 2° shift/day (TBR)
c. Three changes of operational station location while meeting the Attitude Control System pointing performance specifications listed below at less than or equal to 2° shift/day (TBR)
d. Two emergency relocations at less than or equal to 3° shift/day without functional performance degradation
e. From operational station location to end-of-life longitude at up to 2° shift/day (TBR)
f.   Boost from geostationary orbit at end-of-life longitude to end-of-life super synchronous orbit with a perigee of no less than 300 km above geostationary altitude.

ID:
6532

2.5.1.2 Fault handling and recovery

ID:
6529
The spacecraft shall have a fault detection and correction system.

ID:
6530
The spacecraft design shall support detection, isolation, and recovery capabilities for any single fault in the spacecraft bus to ensure the health and safety of the spacecraft.

ID:
6533
The spacecraft shall be capable of surviving the occurrence of any single failure in the spacecraft bus without ground intervention for a minimum of 48 hours (TBR). During fault recovery, science data collection is not required.

ID:
6534

2.5.1.3 Autonomy

ID:
1014
The spacecraft shall be capable of autonomously maintaining on board timing consistent with the ground system.

ID:
6535
The spacecraft shall have an autonomous operations capability which maintains the ability to provide real-time mission data without contact with the ground segment for a period of at least TBD days (threshold) with a (goal) of TBD day.

ID:
6536
The spacecraft shall be capable of maintaining spacecraft and instrument health and safety without ground support.

ID:
6537
All autonomous functions shall be capable of being overridden by ground command.

ID:
1020
The spacecraft shall be capable of maintaining spacecraft and instrument health and safety margins without ground intervention.

ID:
6538

2.5.1.4 Yaw Flip

ID:
6539
The spacecraft contractor **shall** provide the capability for the spacecraft to perform biannual flip about the yaw axis at the choosing of the government where the yaw is defined as the nadir-pointing axis, such that the north face of the spacecraft points south.

ID:
6540
The capability **shall** include all system modifications required to support the yaw flip and maintain performance requirements defined in this document.

ID:
6541

2.5.1.5 Environments

ID:
6542
The Spacecraft shall be designed to meet all requirements during exposure, after exposure, and at the end of life accumulated exposure to both natural and induced environments in orbit as defined in the GIRD.

ID:
6543

2.5.1.6 Mechanical, Thermal, and Electrical Support

ID:
1015
The spacecraft shall provide electrical power, power management, power distribution, energy storage, load shedding, and protection against over voltage, and over current, for all modes.

ID:
1016
The spacecraft structure shall be of sufficient strength and stiffness to maintain structural integrity and withstand all ground testing, handling, transportation, launch, and mission orbit environments.

ID:
6544

The spacecraft shall accommodate the mass needs of the instruments, currently described in the GIRD and the UIIDs, and of the payload services described in future IRDs.

ID:
1017
The spacecraft thermal control design shall maintain all spacecraft subsystems and components, and instrument interfaces at required temperature levels, holding any required thermal gradients, and maintaining temperature stability during all time-varying temperature changes over the mission lifetime for all satellite operations and orientations.

ID:
6545
The battery(s) shall be fully capable of performing its function throughout spacecraft launch modes, transfer orbit modes, on-orbit storage, operational lifetime (including initial outgas, station-keeping, housekeeping, storage) and end-of-life boost modes.

ID:
6546
The battery(s) shall have sufficient capacity to operate on-orbit the spacecraft, instruments, and sensor data downlink, telemetry and command functions, and the payload services through all eclipses of up to 72 minutes of total duration.

ID:
6547
The spacecraft shall support any uplink and retransmission for GOES data Rebroadcast.

ID:
6549

2.5.1.7 Communication Support

ID:
1018
The spacecraft shall provide a telemetry and command system to allow spacecraft stored and real-time control, tasking, software uploads, health and status verifications, command verifications, and anomaly resolution.

ID:
6548
The Spacecraft shall assemble the instrument science and satellite housekeeping packets for downlinking.

ID:
1019
The spacecraft communications described in this Space and Launch Segment shall be sized to down link the mission payload data with 10% margin.

ID:
1021
The spacecraft shall have instrumentation for anomaly detection and fault correction.

ID:
1022
The spacecraft shall have an autonomous operation capability of supporting all routine science operations with no more than TBD minutes of command uplink contact every TBD hours.

ID:
6550

2.5.1.8 Spacecraft Storage

ID:
6400
After integration, testing, and calibration, the spacecraft shall be stored until initiation of the launch process.

ID:
6401
The spacecraft shall be capable of being stored for 5 years on the ground and 5 years on orbit.

ID:
6551

2.5.1.9 Attitude Control

ID:
6552
The ACS **shall** provide periodic estimates of spacecraft position and velocity.

ID:
6553
The ACS **shall** provide periodic estimates of spacecraft inertial attitude.

ID:
6554
The ACS **shall** provide the means to point the spacecraft to a desired attitude.

ID:
6555
The ACS **shall** acquire and maintain a geostationary orbit at a commanded longitude and inclination.

ID:

6556

The ACS **shall** perform momentum compensation for the angular momentum accumulated from all external torques acting on the spacecraft.

ID:
6561

During normal operations, pointing control and knowledge requirements shall be relaxed for no more than one 10-minute period a day to accommodate momentum management. As a goal there should be no pointing degradation during momentum management.

ID:
6557

The ACS **shall** perform control of the solar array.

ID:
6558

The ACS **shall** provide spacecraft attitude knowledge (difference between the true and the actual) attitude at the instrument interfaces (through high frequency updates with measurements in three axes) to support the instruments.

Discussion: The GIRD details this interface.

ID:
6559

The spacecraft **shall** update the attitude estimate at a rate no less than 1 Hz.

ID:
6560

The attitude shall be controlled for earth pointing instruments and for the solar pointing instruments when data is available.

Discussion: The GIRD details this interface.

ID:
1023

2.5.2 Safe Hold Mode

ID:
1024

The spacecraft shall have a Safe Hold mode that can be used in protecting the satellite from catastrophic failures and that can provides a means to return to normal operations. The safe hold mode should provide a thermally safe and power positive attitude, consistent with maintaining the health and safety of the spacecraft and instruments, and maintain a command and telemetry link with the ground for an indefinite period of time.

ID:
1025

2.5.3 Launch vehicle

ID:
1026
The nominal launch vehicle (LV) shall be an Evolved Expendable Launch Vehicle (EELV) class vehicle capable of delivering the satellite to a geostationary transfer orbit or direct injection orbit.

ID:
1027
The LV shall meet the Buy America Act.

ID:
1028
The launch site shall be located at Cape Canaveral Air Station (CCAS), Florida.

ID:
1029
The LV shall have a demonstrated flight record of reliability with a Ps of TBD or better.

ID:
1030
The LV shall not hinder the spacecraft in achieving the required final orbit.

ID:
6399
Removed

ID:
1031

2.6 NOAA mission critical measurements

ID:
1032

2.6.1 Pre-launch Calibration

ID:
1033
The science payload shall be calibrated prior to launch as required to meet the instrument performance requirement specified for each instrument under section 2.10.

All absolute measurements should be in the SI system of units and have reported uncertainties. All claims of traceability regarding these measurements shall be documented. The government will review and assess the validity of the traceability claims pertaining to radiometry and photometry.

ID:
1034

2.7 Satellite Launch Services

ID:
1035

2.7.1 Pre-launch Activities

ID:
1036
The Launch Site Services (LSS) shall have the capability to perform the required pre-launch test and operations necessary, and to successfully launch the GOES-R series satellites.

ID:
1037
The LSS shall provide a payload processing facility for conducting all non-hazardous and hazardous satellite operations.

ID:
1038
The LSS shall have the capability to command and monitor the health and status of the satellite all pre-launch and launch operations.

ID:
1039
The LSS shall provide LV telemetry during all portions of the LV powered flight and during Satellite separation.

ID:
1040
The satellite shall provide telemetry and be configured to receive commands during the entire launch, transfer orbit, and orbit raising to geosynchronous.

ID:
1041

2.7.2 Transmission to Deep Space Network (DSN) Or Similar System during Launch and Orbit Raising (LOR)

ID:

1042

During the launch, transfer orbit and orbit raising phase, satellite to ground communications and transmissions shall go through the DSN or a similar ground network.

ID:
1043

During satellite deployments, motor burns and other critical operations, a primary and backup ground station shall be identified.

ID:
1044

2.7.3 Measurements from Space Weather Instruments during LOR

ID:
1045

To help determine the surrounding satellite environment during the orbit-raising phase, the magnetometer and all SEISS instruments will be operational. Magnetometer and SEISS instrument resources must be provided during this phase. SEISS instruments include the magnetospheric particle sensor (MPS), the solar and galactic proton sensor (SGPS), and the energetic heavy ion sensor (EHIS). Discussion: This impacts battery(s) capabilities.

ID:
1046

2.8 Satellite Post-Launch Test Phase (PLT)

ID:
1047

Post-launch satellite and instrument on-orbit validation of performance shall be accomplished.

ID:
1048

2.8.1 On-orbit acceptance of each instrument

ID:
1049
TBD

ID:
1050

2.8.2 On-orbit acceptance of each satellite

ID:

1051
TBD

ID:
6310

2.8.3 Instrument activation after storage

ID:
6311
After storage and at the earliest safe date, the visible detectors of the science payloads shall be activated. After a period of outgassing and cooling spanning several days, the IR detector of the science payloads shall be activated at the earliest safe date.

ID:
1052

2.9 Deactivation

ID:
6398
Sufficient fuel shall be provided for the end of life (EOL) transfer into a disposal orbit that is 300 km above geostationary orbit in order to meet International Telecommunication Union (ITU) guidelines.

ID:
1053

2.10 Payloads

ID:
1054

2.10.1 ABI (Advanced Baseline Imager)

ID:
1056

(2.10.1) 1. Requirements Overview

ID:
1057
This is NOAA's statement of performance characteristics for an operational advanced imaging instrument drawn from the former GORD-I (December 2002), the newer GPRD-1fd (July 2003 and January, 2004), the signed GPRD-1 (June 2004) and the National Weather Service (NWS) Operational Requirements Document (ORD), (January 1999); from the results of Phase-A instrument concept studies

and Phase-B formulation studies; from scientific technical and cost trade analyses; as well as NOAA-NESDIS's assessment of future NOAA GOES needs. The requirements represent NOAA's advanced baseline for geostationary imaging performance, and thus the notional instrument they define is termed the Advanced Baseline Imager (ABI). The formulation phase was completed in December 2003.

ID:
1058
NOAA assumes that the ABI is distinct from an atmospheric sounding instrument. Spacecraft-specific and ground-processing requirements are excluded wherever possible. However, certain design goals for the ABI, described in Section 2, as well as specific performance characteristics described in Section 3, may result in the inclusion of a ground-processing segment as part of the overall "imager system."

ID:
1059
The final requirements set in this portion of the MRD lie between the threshold and goal values set by the GPRD-1. The requirements in this version of the document form the basis for a NASA procured imager for NOAA are those judged to reflect a balance between NOAA needs, technical and scientific tradeoffs instrument complexity, costs, technology availability, and system (imager and spacecraft) impacts.

ID:
1060

(2.10.1) 2. Design Goals for the Advanced Baseline Imager

ID:
1061
NOAA anticipates that the first ABI will be available for flight on GOES-R. Mass, power, and volume for ABI are not being constrained to that of the imager on the N-P satellite bus. The form of the satellite is unknown at this point in time (see section 2.3.1.) Initially, NOAA used the environmental parameters (mass; power; volume) of the current series of GOES instruments as target limits for concept studies to identify notional imager characteristics; NOAA's intent was to allow potential imager designs to surface that would minimize engineering and cost impacts. Formulation studies now completed have identified each vendor's suggested instrument design. Final numbers are identified in the Unique Instrument Interface Document (UIID) and the General Instrument Requirements Document (GIRD).

ID:
1062
Specific requirements related to the spacecraft interface are given in Section 3.C.8.

ID:
1063

(2.10.1) 3. Performance Characteristics

ID:

1064

Requirements listed in this section result from technical analyses performed by NOAA and are contained in the GPRD-1, which frames the rationale for most ABI performance characteristics. Each technical requirement given below is numbered in order of its appearance in the NWS ORD. Additional requirements that are derived from technical concept studies and trade analyses are subsequently listed.

ID:
1065

A two-level definition is used for NOAA's validated requirements:

ID:
1066

THRESHOLD: The minimum acceptable performance characteristic.

ID:
1067

GOAL: An optimum level of performance, which, if met, could greatly enhance data utility.

ID:
1068

The following GPRD-1 requirements will be met/addressed by ABI. (See section 2.11.3 for relevant comments.) It is critical to note that this information is included here is for reference only and provides traceability to the GPRD-1. The detailed requirements for the ABI are detailed in subsections *after* this section. (See section 2.11.3 for relevant comments.) All parameters listed here are threshold values and may be exceeded to meet goal values. Goal values are currently listed in Appendix A.

ID:
1069

For reference, the distinction between "measure" and "Contribute to determinations of" indicates whether the GPRD-1 requirement is being fully met by a direct measurement performed by the instruments ("measure") or is being determined indirectly from measurements supplied in part or in whole by the instruments ("Contribute to determinations of").

ID:
1070

ABI will *contribute to* determinations of Aerosol Particle Size--Hemispheric in the atmosphere. ABI data will provide the total column value over the full disk to meet 2 km spatial resolution, over the range of TBD, with an accuracy of TBD, 15 min or faster refresh rate, 1.0 km mapping accuracy, and 5 min data latency need. The following details the threshold requirement for the Aerosol Particle Size: full disk coverage, 2 km spatial resolution, with Total Column vertical resolution, over the range of TBD, with an accuracy of TBD, 15 min refresh rate, 1.0 km mapping accuracy, and 5 min data latency.

ID:
1071

ABI will *contribute to* determinations of Aerosol Detection--CONUS (including smoke and dusk) in the atmosphere. ABI data will provide coverage over the full disk to meet 2 km spatial resolution, with total

column vertical resolution, over the range of Binary yes/no detection, with an accuracy of TBD, 5 minute refresh rate, 1 km mapping accuracy, and 15 min data latency need. The following details the threshold requirement for the Aerosol Detection--CONUS (including smoke and dusk): CONUS coverage, 2 km spatial resolution, with total column vertical resolution, over the range of Binary yes/no detection, with an accuracy of TBD, 15 min refresh rate, 1 km mapping accuracy, and 15 min data latency.

ID:
1072
ABI will *contribute to* determinations of Aerosol Detection--Hemispheric (including smoke and dusk) in the atmosphere. ABI data will provide coverage over the full disk to attempt to meet 2 km spatial resolution, with total column vertical resolution, over the range of Binary yes/no detection, with an accuracy of TBD, 15 min refresh rate or faster, 1.0 km mapping accuracy, and 3 min data latency need. The following details the threshold requirement for the Aerosol Detection--Hemispheric (including smoke and dusk): full disk coverage, 2 km spatial resolution, with total column vertical resolution, over the range of Binary yes/no detection, with an accuracy of TBD, 15 min refresh rate, 1.0 km mapping accuracy, and 3 min data latency.

ID:
1073
ABI will *contribute to* determinations of Aerosol Detection--Mesoscale (including smoke and dusk) in the atmosphere. ABI data will provide coverage over the mesoscale to meet 2 km spatial resolution, with total column vertical resolution, over the range of Binary yes/no detection, with an accuracy of TBD, 15 min or faster refresh rate, 1 km mapping accuracy, and 15 min data latency need. The following details the threshold requirement for the Aerosol Detection--Mesoscale (including smoke and dusk): mesoscale coverage, 2 km spatial resolution, with total column vertical resolution, over the range of Binary yes/no detection, with an accuracy of TBD, 15 min refresh rate, 1 km mapping accuracy, and 15 min data latency.

ID:
1074
       ABI will *contribute to* determinations of Dust/Aerosol Loading--CONUS in the atmosphere. ABI data will provide coverage over the CONUS to attempt to meet 10 km spatial resolution, with total column vertical resolution, over the range of Light/ Mod/ Heavy, with an accuracy of TBD, 5 min refresh rate, 5 km mapping accuracy, and 3 min data latency need. The following details the threshold requirement for the Dust/Aerosol Loading--CONUS: CONUS coverage, 10 km spatial resolution, with total column vertical resolution, over the range of Light/ Mod/ Heavy, with an accuracy of TBD, 60 min refresh rate, 5 km mapping accuracy, and 3 min data latency.

ID:
1075
ABI will *contribute to* determinations of Suspended Matter--CONUS in the atmosphere. ABI will provide total column coverage over the CONUS to meet 2 km spatial resolution, with Total Column vertical resolution, over the range of TBD, with an accuracy of TBD, 5 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency need. The following details the threshold requirement for the Aerosol Detection--CONUS: CONUS coverage, 2 km spatial resolution, with Total Column vertical

resolution, over the range of TBD, with an accuracy of TBD, 5 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency.

ID:
1076
ABI will *contribute to* determinations of Suspended Matter: Hemispheric in the atmosphere. ABI provides total column coverage over the full disk to meet 2 km spatial resolution, with Total Column vertical resolution, over the range of TBD, with an accuracy of TBD, 15 min refresh rate, 1.0 km mapping accuracy, and 3 min data latency need. The following details the threshold requirement for the Suspended Matter-Hemispheric: full disk coverage, 2 km spatial resolution, with Total Column vertical resolution, over the range of TBD, with an accuracy of TBD, 15 min refresh rate, 1.0 km mapping accuracy, and 3 min data latency.

ID:
1077
ABI will *contribute to* determinations of Volcanic Ash--Detection and Height in the atmosphere. ABI will provide coverage over the full disk to attempt to meet 2 km spatial resolution, with 2 km (top height) vertical resolution, over the range of 0-50 tons/km^2, with an accuracy of 2 ton/km^2, 15 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency need. The following details the threshold requirement for the Volcanic Ash: full disk coverage, 2 km spatial resolution, with 2 km (top height) vertical resolution, over the range of 0-50 tons/km^2, with an accuracy of 2 ton/km^2, 15 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency.

ID:
1078
        ABI will *measure* Cloud Imagery: Coastal in the atmosphere. ABI will provide coverage over the US Navigable waterways through the Exclusive Economic Zone to meet 1 km (day) and 2 km (night) spatial resolution, with TBD vertical resolution, over the range of TBD, with an accuracy of n/a, 180 min refresh rate, < or = 1 km mapping accuracy, and 15 min data latency need. The following details the threshold requirement for the Cloud Imagery: Coastal: coverage over the US Navigable waterways through the Exclusive Economic Zone, 1 km (day) and 2 km (night) spatial resolution, with TBD vertical resolution, over the range of TBD, with an accuracy of n/a, 180 min refresh rate, < or = 1 km mapping accuracy, and 15 min data latency.

ID:
1079
ABI will *measure* Cloud and Moisture Imagery--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, with n/a vertical resolution, over the range of n/a, with an accuracy of TBD, 5 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency need. The following details the threshold requirement for the Cloud and Moisture Imagery--CONUS: CONUS coverage, 2 km spatial resolution, with n/a vertical resolution, over the range of n/a, with an accuracy of TBD, 5 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency.

ID:
1080

ABI will *measure* Cloud and Moisture Imagery--Hemispheric in the atmosphere. ABI will provide coverage over the full disk to meet 2 km spatial resolution, with n/a vertical resolution, over the range of n/a, with an accuracy of n/a, 15 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency need. The following details the threshold requirement for the Cloud and Moisture Imagery--Hemispheric: full disk coverage, 2 km spatial resolution, with n/a vertical resolution, over the range of n/a, with an accuracy of n/a, 15 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency.

ID:

1081

ABI will *measure* Cloud and Moisture Imagery--Mesoscale in the atmosphere. ABI will provide coverage over a mesoscale to meet 2 km spatial resolution, with n/a vertical resolution, over the range of n/a, with an accuracy of n/a, 30 sec refresh rate, 1.0 km mapping accuracy, and 30 sec data latency need. The following details of the threshold requirement for the Cloud and Moisture Imagery--Mesoscale: mesoscale coverage, 2 km spatial resolution, with n/a vertical resolution, over the range of n/a, with an accuracy of n/a, 30 sec refresh rate, 1.0 km mapping accuracy, and 30 sec data latency.

ID:

1082

ABI will *contribute to* determinations of Cloud Ice Water Path--CONUS (limited cloudiness) in the atmosphere. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, with SFC - 20 km vertical resolution, over the range of 0-1 mm (Day) and 0-0.2 mm (Night), with an accuracy of greater of 0.1 mm or 25% (only thinnest clouds at night), 5 min refresh rate, 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Cloud Ice Water Path--CONUS (limited cloudiness): CONUS coverage, 2 km spatial resolution, 5 minute refresh rate, a vertical range covering the surface to 20 km, with a measurements range of 0-2 mm and a measurement accuracy that is the greater of 0.1 mm or 25% (day) and is achievable for only the thinnest clouds (night), 1.0 km mapping accuracy, and 1 minute data latency.

ID:

1083

ABI will *contribute to* determinations of Cloud Ice Water Path: Hemispheric (limited cloudiness) in the atmosphere. ABI provides coverage over the full disk to meet 2 km spatial resolution, with SFC - 20 km vertical resolution, over the range of 0-1 mm (Day) and 0-0.2 mm (Night), with an accuracy of greater of 0.1 mm or 25% achievable for only the thinnest clouds at night), 15 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency need. The following details the threshold requirement for the Cloud Ice Water Path: Hemispheric (limited cloudiness): full disk coverage, 2 km spatial resolution, with SFC - 20 km vertical resolution, over the range of 0-1 mm (Day) and 0-0.2 mm (Night), with an accuracy of greater of 0.1 mm or 25% (achievable with only thinnest clouds at night), 15 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency.

ID:

1084

ABI will *contribute to* determinations of Cloud Ice Water Path--Mesoscale (limited cloudiness) in the atmosphere. ABI will provide coverage over the mesoscale to meet mesoscale coverage, 2 km spatial resolution, with SFC - 20 km vertical resolution, over the range of 0-1 mm (Day) and 0-0.2 mm (Night), with an accuracy of greater of 0.1 mm or 25% (achievable with only thinnest clouds at night), 15 min

refresh rate, 1.0 km mapping accuracy, and 1 min data latency need. The following details the threshold requirement for the Cloud Ice Water Path--Mesoscale (limited cloudiness): mesoscale coverage, 2 km spatial resolution, with SFC - 20 km vertical resolution, over the range of 0-1 mm (Day) and 0-0.2 mm (Night), with an accuracy of greater of 0.1 mm or 25% (achievable with only thinnest clouds at night), 15 min refresh rate, 1.0 km mapping accuracy, and 1 min data latency.

ID:
1085

ABI will *contribute to* determinations of Cloud Layer/Heights and Thickness--CONUS in the atmosphere with HES. ABI will provide multiple cloud layer imagery coverage over the CONUS every 5 minutes, and with 15 minute data latency, which will facilitate this product that is measured more slowly over the CONUS by the HES-DS. The following details the threshold requirement for the Cloud Layer/Heights and Thickness--CONUS: CONUS coverage, 10 km spatial resolution, with TBD vertical resolution, over the ranges of thickness (only by general cloud type) and heights (up to 5 layers), with an accuracy of thicknesses (TBD) and height (TBD), 60 min refresh rate, 5 km mapping accuracy, and 15 min data latency.

ID:
1086

ABI will *contribute to* determinations of Cloud Layer/Heights and Thickness--Hemisphere in the atmosphere with HES. ABI will provide multiple cloud layer imagery coverage over the Hemisphere at 2 km spatial resolution or finer, with 1 km mapping accuracy, at least every 15 minutes and with a 15 minute data latency need, which will facilitate this product. The following details the threshold requirement for the Cloud Layer/Heights and Thickness--Hemisphere: full disk coverage, 10 km spatial resolution, with TBD vertical resolution, over the range of thickness (only by general cloud type) and heights (up to 5 layers), with an accuracy of thickness (TBD) and height (TBD), 60 min refresh rate, 5 km mapping accuracy, and 15 min data latency.

ID:
1087

ABI will *contribute to* determinations of Cloud Layer/Heights and Thickness--Mesoscale in the atmosphere with HES. ABI will provide multiple cloud layer imagery coverage over all mesoscales every 15 minutes or faster, with 2 km or finer spatial resolution, with the total column samples for the vertical resolution, over the range of TBD, TBD measurement accuracy, with 1 km mapping accuracy. This will facilitate this product. The following details the threshold requirement for the Cloud Layer/Heights and Thickness--Mesoscale: mesoscale coverage, 4 km spatial resolution, with TBD vertical resolution, over the range of thickness (only by general cloud type) and heights of up to 5 layers, with an accuracy of thickness of TBD and height of TBD, 5 min refresh rate, 2 km mapping accuracy, and 10 min data latency need.

ID:
1088

ABI will *contribute to* determinations of Cloud Liquid Water--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, 5 minute refresh rate, a vertical resolution covering the total column, with a measurements range of 0-2 mm, a measurement accuracy that is the greater of 0.1 mm or 25% (day) and is achievable for only the thinnest clouds (night), 1.0 km

mapping accuracy, and 15 minute data latency need. The following details the threshold requirement for the Cloud Liquid Water--CONUS: CONUS coverage, 2 km spatial resolution, 30 minute refresh rate, a vertical resolution covering the total column, with a measurements range of 0-2 mm, a measurement accuracy that is the greater of 0.1 mm or 25% (day) and is achievable for only the thinnest clouds (night), 1.0 km mapping accuracy, and 15 minute data latency.

ID:
1089
ABI will *contribute to* Cloud Liquid Water: Hemispheric in the atmosphere. ABI will provide coverage over the full disk to meet full disk coverage, 2 km spatial resolution, 15 minute or faster refresh rate, a vertical range covering the total column, with a measurements range of 0-2 mm and a measurement accuracy that is the greater of 0.1 mm or 25% (day) and is achievable for only the thinnest clouds (night) that is the greater of 0.1 mm or 25%, 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Cloud Liquid Water: Hemispheric (limited cloudiness): full disk coverage, 2 km spatial resolution, 30 minute refresh rate, a vertical range covering the total column, with a measurements range of 0-2 mm and a measurement accuracy that is the greater of 0.1 mm or 25% (day) and is achievable for only the thinnest clouds (night) that is the greater of 0.1 mm or 25%, 1.0 km mapping accuracy, and 1 minute data latency.

ID:
1090
ABI will *contribute to* determinations of Cloud Liquid Water--Mesoscale in the atmosphere. ABI will provide coverage over the mesoscale to meet 2 km spatial resolution, 30 seconds refresh rate, a vertical resolution covering the total column, with a measurements range of 0-1 mm and a measurement accuracy in the day that is the greater of 0.1 mm or 25% and at night achievable for only the thinnest clouds, 1.0 km mapping accuracy, and 15 minute data latency need. The following details the threshold requirement for the Cloud Liquid Water--Mesoscale: mesoscale coverage, 2 km spatial resolution, 1 minute refresh rate, a vertical resolution covering the total column, with a measurements range of 0-1 mm and a measurement accuracy achievable for only the thinnest clouds in the day that is the greater of 0.1 mm or 25% and at night < 50%, 1.0 km mapping accuracy, and 15 minute data latency.

ID:
1091
ABI will *contribute to* determinations of Cloud Optical Depth--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet cloud optical depth values of > 1, 2 km spatial resolution, 5 minute refresh rate, with a measurement range of 0.5-50 (in O.D. units) and a measurement accuracy of 10%, 1.0 km mapping accuracy, and 15 minute data latency need. The following details the threshold requirement for the Cloud Optical Depth--CONUS: CONUS coverage, cloud optical depth values of > 1, 2 km spatial resolution, 30 minute refresh rate, with a measurement range of 0.5-50 (in O.D. units) and a measurement accuracy of 10%, 1.0 km mapping accuracy, and 15 minute data latency.

ID:
1092
ABI will *contribute to* determinations of Cloud Optical Depth--Hemisphere in the atmosphere. ABI will provide coverage over the full disk to meet 4 km spatial resolution, 15 minute refresh rate or faster, with a measurement range of 0.5-50 (in O.D. units) and a measurement accuracy of 10%, 2.0 km mapping

accuracy, and 1 minute data latency need. The following details the threshold requirement for the Cloud Optical Depth--Hemisphere: full disk coverage, cloud optical depth values of > 1, 4 km spatial resolution, 15 minute refresh rate, with a measurement range of 0.5-50 (in O.D. units), a measurement accuracy of 10%, 1.0 km mapping accuracy, and 1 minute data latency.

ID:
5836

ABI will *contribute to* determinations of Cloud Particle Size Distribution -- CONUS in the atmosphere. ABI will provide cloud top measurements at the observation height. ABI will have coverage over the full disk to meet the 2 km spatial resolution, over the range of 0 - 50 µm, with an accuracy of 4 µm, 5 min refresh rate, 1.0 km mapping accuracy and 1 min data latency. The following details the threshold requirement for the Cloud Particle Size Distribution--CONUS: 2 km spatial resolution, 5 minute refresh rate, a vertical range of at the cloud top height, with a measurements range of 0-50 um with a measurement accuracy of 4 um, 1.0 km mapping accuracy, and 1 minute data latency.

ID:
1093

ABI will *contribute to* determinations of Cloud Particle Size Distribution: Hemispheric in the atmosphere. ABI will provide cloud top measurements at the observation height. ABI will have coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate or faster, a vertical range of only cloud top height, with a measurements range of 0-50 um, a measurement accuracy of 4 um, 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Cloud Particle Size Distribution--Hemisphere: 2 km spatial resolution, 15 minute refresh rate, a vertical range of at the cloud top height, with a measurements range of 0-50 um, a measurement accuracy of 4 um, 1.0 km mapping accuracy, and 1 minute data latency.

ID:
1094

ABI will *contribute to* determinations of Cloud Particle Size Distribution--Mesoscale in the atmosphere. ABI will provide total column coverage over the mesoscale to meet 2 km spatial resolution, 30 second refresh rate, a vertical range of at cloud height, with a measurement range of 0-50 um with a measurement accuracy of 4 um, 1.0 km mapping accuracy, and 1 minute data latency need. The following details of the threshold requirement for the Cloud Particle Size Distribution--Mesoscale: mesoscale coverage, 2 km spatial resolution, 5 minute refresh rate, a vertical range of at cloud height, with a measurement range of 0-50 um with a measurement accuracy of 4 um, 1.0 km mapping accuracy, and 1 minute data latency.

ID:
1095

ABI will *contribute to* determinations of Cloud Top Phase--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, 5 minute refresh rate, vertical resolution of at cloud top, measurement range of liquid/solid/supercooled/mixed, measurement accuracy of TBD, 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Cloud Top Phase--CONUS: CONUS coverage, 2 km spatial resolution, 5 minute refresh rate, vertical resolution of at cloud top, measurement range of liquid/solid/supercooled/mixed, measurement accuracy of TBD, 1.0 km mapping accuracy, and 1 minute data latency.

ID:
1096
ABI will *contribute to* determinations of Cloud Top Phase: Hemispheric in the atmosphere. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, vertical resolution of at cloud top, with a measurement range of liquid/solid/supercooled/mixed, measurement accuracy of TBD, 1.0 km mapping accuracy, and 1 minute data latency. The following details the threshold requirement for the Cloud Top Phase: Hemispheric: 2 km spatial resolution, 15 minute refresh rate, vertical resolution of at cloud top, with a measurement range of liquid/solid/supercooled/mixed, measurement accuracy of TBD, 1.0 km mapping accuracy, and 1 minute data latency.

ID:
1097
ABI will *contribute to* determinations of Cloud Phase--Mesoscale in the atmosphere. ABI will provide coverage over the mesoscale to meet 2 km spatial resolution, 30 second refresh rate, with vertical resolution of at the cloud top, with a measurements range of liquid/solid/supercooled/mixed with a measurement accuracy of TBD, 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Cloud Phase--Mesoscale: mesoscale coverage, 2 km spatial resolution, 5 minute refresh rate, with vertical resolution of at the cloud top, with a measurements range of liquid/solid/supercooled/mixed with a measurement accuracy of TBD, 1.0 km mapping accuracy, and 1 minute data latency need.

ID:
1098
     ABI will *contribute to* determinations of Cloud Top Height--CONUS in the atmosphere with its fast coverage and fine spatial resolution, although HES-DS will produce the vertical resolution for the cloud top height. The following details the threshold requirement for Cloud Top Height--CONUS: CONUS coverage, 10 km spatial resolution, (Sfc-500 mb) 300-500 m vertical resolution, (500-300 mb) 1-2 km vertical resolution, over the cloud top height range of 100m - 300hPa, with an accuracy of (Sfc-500 mb) 300-500 m and (500-300 mb): 1-2 km, 60 min refresh rate, 5 km mapping accuracy, and 3 min data latency.

ID:
1099
ABI will *contribute to* determinations of Cloud Top Height: Hemispheric in the atmosphere with its fast coverage and fine spatial resolution, although HES-DS will produce the vertical resolution for the cloud top height. The following details the threshold requirement for Cloud Top Height--Hemispheric: full disk coverage, 10 km spatial resolution, (Sfc-500 mb) 300-500 m vertical resolution, (500-300 mb) 1-2 km vertical resolution, over the cloud top height range of 0-15 km, with an accuracy of (Sfc-500 mb) 300-500 m and (500-300 mb): 1-2 km, 60 min refresh rate, 5 km mapping accuracy, and 3 min data latency.

ID:
1100
     ABI will *contribute to* determinations of Cloud Top Height--Mesoscale in the atmosphere with its fast coverage and fine spatial resolution, although HES-SW/M will produce the vertical resolution for

the cloud top height. The following details the threshold requirement for Cloud Top Height--Mesoscale: mesoscale coverage, 4 km spatial resolution, (Sfc-500 mb) 300-500 m vertical resolution, (500-300 mb) 1-2 km vertical resolution, over the cloud top height range of 0-20 km, with an accuracy of (Sfc-500 mb) 300-500 m and (500-300 mb): 1-2 km, 5 min refresh rate, 5 km mapping accuracy, and 3 min data latency.

ID:
1101
ABI will *contribute to* determinations of Cloud Top Pressure--CONUS in the atmosphere (by contributing to cloud top height) with its fast coverage and fine spatial resolution, although HES-DS will produce the vertical resolution for the Cloud Top Pressure. The following details the threshold requirement for Cloud Top Pressure--CONUS: CONUS coverage, 10 km spatial resolution, (Sfc-500 mb) 300-500 m vertical resolution, (500-300 mb) 1-2 km vertical resolution, over the range of 100m at 300hPa, with an accuracy of (Sfc-500 mb) 300-500 m and (500-300 mb): 1-2 km, 60 min refresh rate, 5 km mapping accuracy, and 10 min data latency.

ID:
1102
ABI will *contribute to* determinations of Cloud Top Pressure--Hemispheric in the atmosphere (by contributing to cloud top height) with its fast coverage and fine spatial resolution, although HES-DS will produce the vertical resolution for the Cloud Top Pressure. The following details the threshold requirement for Cloud Top Pressure--Hemispheric: full disk coverage, 10 km spatial resolution, (Sfc-500 mb) 300-500 m vertical resolution, (500-300 mb) 1-2 km vertical resolution, over the range of TBD, with an accuracy of (Sfc-500 mb) 300-500 m and (500-300 mb): 1-2 km, 60 min refresh rate, 5 km mapping accuracy, and 3 min data latency.

ID:
1103
Removed

ID:
1104
ABI will *contribute to* determinations of Cloud Top Temperature: Hemispheric in the atmosphere. ABI will provide total column coverage over the full disk to meet vertical resolution of at cloud top; 2 km spatial resolution, 15 minute refresh rate, with a measurement range of 180 to 300 K with 1 K measurement accuracy, 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Cloud Top Temperature--Hemisphere: full disk coverage, vertical resolution of at cloud top; 2 km spatial resolution, 15 minute refresh rate, with a measurement range of 180 to 300 K with 1 K measurement accuracy, 1.0 km mapping accuracy, and 1 minute data latency.

ID:
1105
ABI will *contribute to* determinations of Cloud Top Temperature--Mesoscale in the atmosphere. ABI will provide coverage over the mesoscale to meet vertical resolution at cloud tops; 2 km spatial

resolution, 5 minute refresh rate, with a measurement range of 180 to 300 K with 1.0 K measurement accuracy, 1.0 km mapping accuracy, and 5 minute data latency. The following detail the threshold requirement for the Cloud Top Temperature--Mesoscale: mesoscale coverage, vertical resolution at cloud tops; 2 km spatial resolution, 5 minute refresh rate, with a measurement range of 190 to 300 K with 1.0 K measurement accuracy, 1.0 km mapping accuracy, and 5 minute data latency.

ID:
1106
ABI will *contribute to* determinations of Cloud Type--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, with TBD vertical resolution, with a accuracy of TBD, 5 minute refresh rate, with a measurement range of 7 cloud types, 1 km mapping accuracy, and 10 minute data latency need. The following details the threshold requirement for the Cloud Type--CONUS: CONUS coverage, 10 km spatial resolution, with TBD vertical resolution, with an accuracy of TBD, 30 minute refresh rate, with a measurement range of 7 cloud types, 5 km mapping accuracy, and 10 minute data latency.

ID:
1107
ABI will *contribute to* determinations of Cloud Type--Hemispheric in the atmosphere. ABI provides coverage over the full disk to meet 2 km spatial resolution, with TBD vertical resolution, over the measurement range of 7 types, with an accuracy of TBD, 15 min refresh rate, 1 km mapping accuracy, and 1 min data latency need. The following details the threshold requirement for the Cloud Type--Hemispheric: full disk coverage, 2 km spatial resolution, with TBD vertical resolution, over the measurement range of 7 types, with an accuracy of TBD, 15 min refresh rate, 1 km mapping accuracy, and 1 min data latency.

ID:
1108
ABI will *contribute to* determinations of Cloud Type--Mesoscale in the atmosphere. ABI provides coverage over the mesoscale to meet 2 km spatial resolution, with n/a vertical resolution, over the measurement range of 7 types, with an accuracy of TBD, 30 second refresh rate, 1 km mapping accuracy, and TBD data latency need. The following details the threshold requirement for the Cloud Type--Mesoscale: mesoscale coverage, TBD spatial resolution, with TBD vertical resolution, over the measurement range of 7 types, with an accuracy of TBD, TBD refresh rate, TBD mapping accuracy, and TBD data latency.

ID:
1109
ABI will *contribute to* determinations of Convective Initiation in the atmosphere. ABI provides coverage over the CONUS to meet 2 km spatial resolution, with TBD vertical resolution, over the measurement range of TBD, with an accuracy of TBD, 5 min refresh rate, 1.0 km mapping accuracy, and 3 min data latency. The following details the threshold requirement for the Convective Initiation: CONUS coverage, 2 km spatial resolution, with TBD vertical resolution, over the measurement range of TBD, with an accuracy of TBD, 15 min refresh rate, 1.0 km mapping accuracy, and 3 min data latency.

ID:

1110
ABI will *measure* **Enhanced "V" / Overshooting Cloud Top Detection‑‑CONUS** in the atmosphere. ABI provides coverage over the CONUS to meet 2 km spatial resolution, with n/a vertical resolution, 5 minute refresh rate, with a measurement range of 0-1 binary detection (160-270 K), a measurement accuracy of 10% detection (1.0 K cloud top), 1.0 km mapping accuracy, and 5 minute data latency need. The following details of the threshold requirement for the Enhanced "V" / Overshooting Cloud Top Detection‑‑CONUS: 2 km spatial resolution, with TBD vertical resolution, 15 minute refresh rate, with a measurement range of 0-1 binary detection (160-270 K) and a measurement accuracy of 10% detection (1.0 K cloud top), 1.0 km mapping accuracy, and 5 minute data latency.

ID:
1111
ABI will *measure* **Enhanced "V" / Overshooting Cloud Top Detection‑‑Mesoscale** in the atmosphere. ABI provides coverage over the mesoscale to meet 2 km spatial resolution, with n/a vertical resolution, 30 second refresh rate, with a measurement range of 0-1 binary detection (160-270 K) and a measurement accuracy of 10% detection (1.0 K cloud top), 1.0 km mapping accuracy, and 5 minute data latency. The following details the threshold requirement for the Enhanced "V" / Overshooting Cloud Top Detection‑‑Mesoscale: mesoscale coverage, 2 km spatial resolution, with TBD vertical resolution, 5 minute refresh rate, with a measurement range of 0-1 binary detection (160-270 K) and a measurement accuracy of 10% detection (1.0 K cloud top), 1.0 km mapping accuracy, and 5 minute data latency need.

ID:
1112
ABI will *contribute to* determinations of Hurricane Intensity in the atmosphere. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, with TBD vertical resolution, a measurement range of TBD, a measurement accuracy of 5 m/s, 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Hurricane Intensity: full disk coverage, 2 km spatial resolution, 30 minute refresh rate, with TBD vertical resolution, a measurement range of TBD, a measurement accuracy of 5 m/s, 1.0 km mapping accuracy, and 1 minute data latency need.

ID:
1113
ABI will *measure* Imagery: All weather- Day/Night in the atmosphere for the clear and above cloud regions only. ABI will provide for the clear and above cloud regions only coverage over the full disk to meet 2 km spatial resolution, with n/a vertical resolution, 15 minute refresh rate, with measurement range of TBD, measurement accuracy of TBD, 1.0 km mapping accuracy, and TBD minute data latency need. The following details the threshold requirement for the clear and above cloud regions only for Imagery: All weather- Day/Night: 2 km spatial resolution, with n/a vertical resolution, TBD refresh rate, with measurement range of TBD, measurement accuracy of TBD, 1.0 km mapping accuracy, and TBD minute data latency need.

ID:
1114
ABI will *measure* Low Cloud and Fog in the atmosphere. ABI provides coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, of 0.5 km (depth), with a measurements range

Fog/No Fog with 70% detection (30% false alarm), 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Low Cloud and Fog: full disk coverage, 2 km spatial resolution, 15 minute refresh rate, of 0.5 km (depth), with a measurements range Fog/No Fog with 70% detection (30% false alarm), 1.0 km mapping accuracy, and 1 minute data latency need.

ID:
1115
ABI will *contribute to* determinations of **Turbulence--Hemispheric** in the atmosphere. ABI provides coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, with a measurement range of binary moderate or greater (over 0.1 km - 4 km) vertically, and a measurement accuracy of TBD, with vertical resolution of n/a, 1.0 km mapping accuracy, and 1 minute data latency need. The following details of the threshold requirement for the Turbulence--Hemispheric: full disk coverage, 2 km spatial resolution, 15 minute refresh rate, with a measurement range of binary moderate or greater (over 0.1 km - 4 km) vertically, and a measurement accuracy of TBD, with vertical resolution of (Sfc-500 mb) 300-500 m, (500-300 mb) 1-2 km, (300-100 mb) 1-2 km, (100 mb and up) 2-3 km, 1.0 km mapping accuracy, and 1 minute data latency need.

ID:
1116
ABI will *contribute to* determinations of **Turbulence--Mesoscale** in the atmosphere. ABI provides coverage over the mesoscale to meet 2 km spatial resolution, 30 second refresh rate, with a measurement range of binary moderate or greater (over 0.1 km - 4 km) vertically, and a measurement accuracy of TBD, with vertical resolution of n/a, 1.0 km mapping accuracy, and 5 minute data latency need. The following details of the threshold requirement for the Turbulence--Mesoscale: mesoscale coverage, 2 km spatial resolution, 15 minute refresh rate, with a measurement range of binary moderate or greater (over 0.1 km - 4 km) vertically, and a measurement accuracy of TBD, with vertical resolution of (Sfc-500 mb) 300-500 m, (500-300 mb) 1-2 km, (300-100 mb) 1-2 km, (100 mb and up) 2-3 km, 1.0 km mapping accuracy, and 1 minute data latency need.

ID:
1117
ABI will *contribute to* determinations of Visibility: Coastal in the atmosphere. ABI will provide coverage over the US Navigable waterways through the Exclusive Economic Zone to meet 2 km spatial resolution, < 3 hour refresh rate, vertical resolution of n/a, with a measurement range of 0-3.2 km and a measurement accuracy of TBD, contributing 1.0 km mapping accuracy, and 15 minute data latency. The following details the threshold requirement for the Visibility: Coastal: covering US Navigable waterways through the Exclusive Economic Zone with 3 km spatial resolution, 3 hour refresh rate, vertical resolution of TBD, with a measurement range of 0-3.2 km and a measurement accuracy of TBD, contributing 1.0 km mapping accuracy, and 15 minute data latency.

ID:
1118
ABI will *measure* Visibility: Hemispheric in the atmosphere. ABI will provide coverage over the full disk to meet 2 km spatial resolution, < 60 minute refresh rate, with a vertical resolution of n/a, with a measurement range of 0-30 km and a measurement accuracy of (TBS), TBD mapping accuracy and 15 minute data latency need. The following details the threshold requirement for the Visibility:

Hemispheric: 10 km spatial resolution, 60 minute refresh rate, with a vertical resolution of TBS, with a measurement range of 0-30 km and a measurement accuracy of (TBS), TBD mapping accuracy and 15 minute data latency.

ID:
1119
ABI will *measure* Probability of Rainfall in the atmosphere. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, TBD vertical resolution, with a measurements range of 0-100% with 25% measurement accuracy, 1.0 km mapping accuracy, and 5 minute data latency need. The following details the threshold requirement for the Probability of Rainfall: full disk coverage, 2 km spatial resolution, 15 minute refresh rate, TBD vertical resolution, with a measurements range of 0-100% with 25% measurement accuracy, 1.0 km mapping accuracy, and 5 minute data latency need.

ID:
1120
ABI will *measure* Rainfall Potential in the atmosphere. ABI provides coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, TBD vertical resolution, with a measurements range of 0-100 mm/hr with 5 mm/hr measurement accuracy, 1.0 km mapping accuracy, and 5 minute data latency need. The following details the threshold requirement for the Rainfall Potential: full disk coverage, 2 km spatial resolution, 15 minute refresh rate, TBD vertical resolution, with a measurements range of 0-100 mm/hr with 5 mm/hr measurement accuracy, 1.0 km mapping accuracy, and 5 minute data latency need.

ID:
1121
ABI will *measure* of Rainfall Potential / Quantitative Precipitation Estimate in the atmosphere. ABI provides coverage over the full disk to meet 2 km spatial resolution, TBD vertical resolution, 15 minute refresh rate, TBD vertical resolution, with a measurements range of 0-100 mm/hr with 2 mm/hr measurement accuracy, 1.0 km mapping accuracy, and 1 minute data latency need. The following details the threshold requirement for the Rainfall Potential / Quantitative Precipitation Estimate: 2 km spatial resolution, TBD vertical resolution, 15 minute refresh rate, TBD vertical resolution, with a measurements range of 0-100 mm/hr with 2 mm/hr measurement accuracy, 1.0 km mapping accuracy, and 1 minute data latency need.

ID:
1122
ABI will *measure* Derived Stability--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, TBD vertical resolution, 5 minute refresh rate, with a measurement range of TBD and a measurement accuracy of TBD, 1.0 km mapping accuracy, and 3 minute data latency need. The following details the threshold requirement for the Derived Stability-- CONUS: CONUS coverage, 4 km spatial resolution, TBD vertical resolution, 30 minute refresh rate, with a measurement range of TBD and a measurement accuracy of TBD, 1.0 km mapping accuracy, and 3 minute data latency.

ID:
1123

ABI will *measure* Derived Stability--Mesoscale in the atmosphere. ABI will provide coverage over the mesoscale to meet 2 km spatial resolution, 15 minute refresh rate, TBD vertical resolution, with a measurements range of 0-5000 J/kg and a 10% accuracy, 1.0 km mapping accuracy, and 15 minute data latency need. The following details the threshold requirement for the Derived Stability--Mesoscale: mesoscale coverage, 2 km spatial resolution, 15 minute refresh rate, TBD vertical resolution, with a measurements range of 0-5000 J/kg and a 10% accuracy, 1.0 km mapping accuracy, and 15 minute data latency need.

ID:
1124

ABI will *contribute to* determinations in Moisture Flux--CONUS in the atmosphere (by contributing wind determinations) although HES-DS will produce the vertical resolution for Moisture Flux. The following details the threshold requirement for Moisture Flux--CONUS: CONUS coverage, 10 km spatial resolution, with vertical resolution of (Sfc-500 mb) 300-500 m, (500-300 mb) 1-2 km, (300-100 mb) 1-2 km, (100 mb and up) 2-3 km, over the range of 0 - 20 g/kg/h, with an accuracy of 10%, 60 min refresh rate, 5 km mapping accuracy, and 3 min data latency need.

ID:
1125

ABI will *contribute to* determinations in Moisture Flux: Hemispheric in the atmosphere (by contributing wind determination), although HES-DS will produce the vertical resolution for Moisture Flux. The following details the threshold requirement for Moisture Flux--Hemispheric: full disk coverage, 10 km spatial resolution, with vertical resolution of (Sfc-500 mb) 300-500 m, (500-300 mb) 1-2 km, (300-100 mb) 1-2 km, (100 mb and up) 2-3 km, over the range of 0 - 20 g/kg/h, with an accuracy of 10%, 60 min refresh rate, 5 km mapping accuracy, and 3 min data latency need.

ID:
1126

ABI will *contribute to* determinations in Moisture Flux--Mesoscale in the atmosphere (by contributing wind determination), although HES-SW/M will produce the vertical resolution for Moisture Flux. The following details the threshold requirement for Moisture Flux--Mesoscale: mesoscale coverage, 4 km spatial resolution, with vertical resolution of (Sfc-500 mb) 300-500 m, (500-300 mb) 1-2 km, (300-100 mb) 1-2 km, (100 mb and up) 2-3 km, over the range of 0 - 20 g/kg/h, with an accuracy of 10%, 15 min refresh rate, 5 km mapping accuracy, and 3 min data latency need.

ID:
1127

ABI will *measure* Clear Sky Masks--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, with n/a vertical resolution, 5 minute refresh, 1 km mapping accuracy, over the measurement range of 0-1 with 10% measurement accuracy, and 15 minute latency. The following details the threshold requirement for the Clear Sky Masks--CONUS: 2 km spatial resolution, with n/a vertical resolution, 15 minute refresh, 1 km mapping accuracy, over the measurement range of 0-1 with 10% measurement accuracy, and 15 minute latency.

ID:

1128

ABI will *measure* Clear Sky Masks: Hemispheric in the atmosphere. ABI will provide coverage over the full disk to meet 2 km spatial resolution, with n/a vertical resolution, 15 minute refresh, 1 km mapping accuracy, over the measurement range of 0-1 with 10% measurement accuracy, and 15 minute latency. The following details the threshold requirement for the Clear Sky Masks: Hemispheric: 2 km spatial resolution, with n/a vertical resolution, 15 minute refresh, 1 km mapping accuracy, over the measurement range of 0-1 with 10% measurement accuracy, and 15 minute latency.

ID:

1129

ABI will *measure* Clear Sky Masks--Mesoscale in the atmosphere. ABI will provide coverage over the mesoscale to meet 2 km spatial resolution, with n/a vertical resolution, 30 second refresh rate, with a measurements range of 0-1 and a 10% accuracy, 1.0 km mapping accuracy, and 5 minute data latency need. The following details the threshold requirement for the Clear Sky Masks--Mesoscale: 2 km spatial resolution, with n/a vertical resolution, 1 minute refresh rate, with a measurements range of 0-1 and a 10% accuracy, 1.0 km mapping accuracy, and 5 minute data latency.

ID:

1130

ABI will *contribute to* determinations of Downward Solar Insolation: Surface / CONUS in the atmosphere. ABI provides coverage over the CONUS to meet Surface / CONUS : 25 km spatial resolution, with n/a vertical resolution, < 60 minute refresh rate, with a measurement range of 0-1500 W/m^2 and measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), 2.0 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Downward Solar Insolation: Surface / CONUS: 25 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, with a measurement range of 0-1500 W/m^2 and measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), 2.0 km mapping accuracy, and 60 minute data latency.

ID:

5844

ABI will *contribute to* determinations of **Absorbed Shortwave Radiation: Surface / Mesoscale** in the atmosphere because a proxy for this product is determined by NOAA from insolation and albedo. The validity of this proxy is beyond the scope of this document. ABI will provide coverage over the mesoscale to meet 2 km spatial resolution, < 60 minute refresh rate, mapping accuracy of 1.0 km, with a measurement range of 0-700 W/m^2, a measurement accuracy of 7 W/m^2, and 60 minute data latency need. The following details the threshold requirement for the Absorbed Shortwave Radiation: Surface / Mesoscale: 5 km spatial resolution, 60 minute refresh rate, mapping accuracy of 1.0 km, with a measurement range of 0-700 W/m^2, a measurement accuracy of 7 W/m^2, and 60 minute data latency.

ID:

5845

ABI will *contribute to* determinations of **Downward Longwave Radiation: Surface / CONUS** in the atmosphere because a proxy for this product is determined by NOAA from the shortwave radiation. The validity of this proxy is beyond the scope of this document. ABI will provide coverage over CONUS to meet 2 km spatial resolution, < 60 minute refresh rate, mapping accuracy of 1 km, with

a measurement range of 0-700 W/m^2, a measurement accuracy of TBD, and 60 minute data latency need. The following details of the threshold requirement for the Downward Longwave Radiation: Surface / CONUS: CONUS coverage, 25 km spatial resolution, 60 minute refresh rate, mapping accuracy of 5 km, with a measurement range of 0-700 W/m^2, a measurement accuracy of TBD, and 60 minute data latency.

ID:
5846
ABI will *contribute to* determinations of **Downward Longwave Radiation--Surface / Hemispheric** in the atmosphere because a proxy for this product is determined by NOAA from the shortwave radiation. The validity of this proxy is beyond the scope of this document. ABI will provide coverage over the full disk to meet the Downward Longwave Radiation--Surface / Hemispheric: full disk coverage, 2 km spatial resolution, 15 minute refresh rate, mapping accuracy of 1 km, with a measurement range of TBD, a measurement accuracy of TBS, and TBD data latency need. The following details the threshold requirement for the Downward Longwave Radiation: Surface / Hemispheric 100 km spatial resolution, 60 minute refresh rate, mapping accuracy of TBD km, with a measurement range of TBD, a measurement accuracy of TBS, and TBD data latency need.

ID:
5864
ABI will *contribute to* determinations of **Downward Solar Insolation--Surface / CONUS** in the atmosphere. The validity of this proxy is beyond the scope of this document. ABI will provide coverage over the CONUS to meet 25 km spatial resolution, with n/a vertical resolution, < 60 minute refresh rate, with a measurement range of 0-1500 W/m^2, measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m2 at typical value/mid-point (350 W/m^2), 2.0 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Downward Solar Insolation--Surface / CONUS: CONUS coverage, 25 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, with a measurement range of 0-1500 W/m^2 and measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), 2.0 km mapping accuracy, and 60 minute data latency.

ID:
1131
ABI will *contribute to* determinations of **Downward Solar Insolation--Surface / Hemispheric** in the atmosphere. ABI will provide coverage over the full disk to meet < 50 km spatial resolution, with n/a vertical resolution, < 60 minute refresh rate, 0-1500 W/m^2 measurement range, measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), TBD km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Downward Solar Insolation--Surface / Hemispheric: 50 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, 0-1500 W/m^2 measurement range, measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), TBD km mapping accuracy, and 60 minute data latency.

ID:
1132

ABI will *contribute to* determinations of **Downward Solar Insolation--Surface / Mesoscale** in the atmosphere. ABI will provide coverage over the full disk to meet < 5 km spatial resolution, with n/a vertical resolution, < 60 minute refresh rate, 0-1500 W/m^2 measurement range, measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), (TBS) km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Downward Solar Insolation--Surface / Mesoscale: mesoscale coverage, 5 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, 0-1500 W/m^2 measurement range, measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), (TBS) km mapping accuracy, and 60 minute data latency.

ID:
1133

ABI will *contribute to* determinations of **Reflected Solar Insolation--TOA/ CONUS** in the atmosphere. ABI provides coverage over the CONUS to meet < 25 km spatial resolution, <60 minute refresh rate, 0-1500 W/m^2 measurement range, measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), 2.0 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Downward Solar Insolation--TOA / CONUS: CONUS coverage, 25 km spatial resolution, 60 minute refresh rate, 0-1500 W/m^2 measurement range, measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), 2.0 km mapping accuracy, and 60 minute data latency.

ID:
1134

ABI will *contribute to* determinations of **Reflected Solar Insolation--TOA / Hemispheric** in the atmosphere. ABI will provide coverage over the full disk to meet < 100 km spatial resolution, with n/a vertical resolution, < 60 minute refresh rate, with measurement range of 0-1500 W/m^2 measurement range, measurement accuracy of 60 W/m^2 at high end of range (1500 W/m^2) +/- 40 W/m^2 at typical value/mid-point (350 W/m^2), 2.0 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Reflected Solar Insolation--TOA / Hemispheric: full disk coverage, 100 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, with measurement range of TBD, measurement accuracy of TBD, TBD km mapping accuracy, and TBD data latency.

ID:
1135

ABI will *measure* Ozone Total--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet 10 km spatial resolution, with TBD vertical resolution, 60 minute refresh rate, with a measurement range of 100-650 (DU) and measurement accuracy of 6%, 5 km mapping accuracy, and 5 minute data latency need. The following details the threshold requirement for the Ozone Total--CONUS: CONUS coverage, 10 km spatial resolution, with TBD vertical resolution, 60 minute refresh rate, with a measurement range of 100-650 (DU) and measurement accuracy of 6%, 5 km mapping accuracy, and 5 minute data latency.

ID:
1136

ABI will *measure* Ozone Total--Hemisphere in the atmosphere. ABI will provide coverage over the full disk to meet 10 km spatial resolution, with TBD vertical resolution, 60 minute refresh rate, 5 with a measurement range of 100-650 (DU), and measurement accuracy of 6%, 5 km mapping accuracy, and 5 minute data latency need. The following detail of the threshold requirement for the Ozone Total--Hemispheric: full disk coverage, 10 km spatial resolution, with TBD vertical resolution, 60 minute refresh rate, 5 with a measurement range of 100-650 (DU) and measurement accuracy of 6%, 5 km mapping accuracy, and 5 minute data latency.

ID:
5838

ABI will *measure* SO_2 Detection in the atmosphere. ABI will provide coverage over the full disk to meet <5 km spatial resolution, with total column vertical resolution, < 60 minute refresh rate, over the total column, with a measurement range of binary yes/no detection above TBD Dobson Units (DU) and measurement accuracy of 1%, 1 km mapping accuracy, and 15 minute data latency need. The following details the threshold requirement for SO_2 Detection: full disk coverage, 5 km spatial resolution, with total column vertical resolution, 60 minute refresh rate, over the total column, with a measurement range of binary yes/no detection above TBD Dobson Units (DU) and measurement accuracy of 1%, 1 km mapping accuracy, and 15 minute data latency.

ID:
1137

ABI will *measure* Derived Motion Winds--CONUS in the atmosphere. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, 5 minute refresh rate, with a 4 levels vertical range (including low/mid/mid-high, high), with a measurement range of 0-155 m/s (0-300 kts) and measurement accuracy of 6 m/s (high level) or 4 m/s (mid level) or 2.5 m/s (low level), 1 km mapping accuracy, and 3 minute data latency need. The following details of the threshold requirement for the Derived Motion Winds--CONUS: CONUS coverage, 2 km spatial resolution, 5 minute refresh rate, with a 4 levels vertical range (including low/mid/mid-high, high), with a measurement range of 0-155 m/s (0-300 kts) and measurement accuracy of 6 m/s (high level) or 4 m/s (mid level) or 2.5 m/s (low level), 1 km mapping accuracy, and 3 minute data latency.

ID:
1138

ABI will *measure* Derived Motion Winds--Hemisphere in the atmosphere. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 5 minute refresh rate (one of three for triplet), with a 4 levels vertical range (including low/mid/mid-high, high), with a measurement range of 0-155 m/s (0-300 kts) and measurement accuracy of 6 m/s (high level) or 4 m/s (mid level) or 2.5 m/s (low level), 1 km mapping accuracy, and 3 minute data latency need. The following details the threshold requirement for the Derived Motion Winds--Hemispheric: full disk coverage, 2 km spatial resolution, 5 minute refresh rate (one of three for triplet), with a 4 levels vertical range (including low/mid/mid-high, high), with a measurement range of 0-155 m/s (0-300 kts) and measurement accuracy of 6 m/s (high level) or 4 m/s (mid level) or 2.5 m/s (low level), 1 km mapping accuracy, and 3 minute data latency.

ID:
1139

ABI will *measure* Derived Motion Winds--Mesoscale in the atmosphere. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 5 minute refresh rate, with a 4 levels vertical range (including low/mid/mid-high, high), with a measurement range of 0-155 m/s (0-300 kts) and measurement accuracy of 6 m/s (high level) or 4 m/s (mid level) or 2.5 m/s (low level), 1 km mapping accuracy, and 3 minute data latency need. The following details the threshold requirement for the Derived Motion Winds--Mesoscale: mesoscale coverage, 2 km spatial resolution, 5 minute refresh rate, with a 4 levels vertical range (including low/mid/mid-high, high), with a measurement range of 0-155 m/s (0-300 kts) and measurement accuracy of 6 m/s (high level) or 4 m/s (mid level) or 2.5 m/s (low level), 1 km mapping accuracy, and 3 minute data latency.

ID:
1140
ABI will *contribute to* determinations of **Microburst Windspeed Potential** in the atmosphere. ABI will provide coverage over the CONUS to meet < 10 km spatial resolution, with TBD vertical resolution, < 60 minute refresh, over the range of TBD, with a measurement accuracy of TBD, 5 km mapping accuracy, and 3 minute data latency need. The following details the threshold requirement for the **Microburst Windspeed Potential**: CONUS coverage, 10 km spatial resolution, with TBD vertical resolution, 60 minute refresh, over the range of TBD, with a measurement accuracy of TBD, 5 km mapping accuracy, and 3 minute data latency.

ID:
1141
ABI will *measure* Fire / Hot Spot Imagery--CONUS on the land. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, with n/a vertical resolution, 5 minute refresh rate, with a measurement range of 275-400 K and measurement accuracy of < 2 K, 1 km mapping accuracy, and 5 minute data latency need. The following details the threshold requirement for the Fire / Hot Spot Imagery--CONUS: CONUS coverage, 2 km spatial resolution, with n/a vertical resolution, 5 minute refresh rate, with a measurement range of 275-400 K and measurement accuracy of 2 K, 1 km mapping accuracy, and 5 minute data latency.

ID:
1142
ABI will *measure* Fire / Hot Spot Imagery--Hemispheric on the land. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, with a measurement range of 275-400 K and measurement accuracy of < 2 K, 1 km mapping accuracy, and 5 minute data latency need. The following details the threshold requirement for the Fire / Hot Spot Imagery--Hemispheric: full disk coverage, 2 km spatial resolution, 15 minute refresh rate, with a measurement range of 275-400 K and measurement accuracy of 2 K, 1 km mapping accuracy, and 5 minute data latency.

ID:
1143
ABI will *contribute to* determinations of Flood Standing Water--Hemisphere on the land. ABI will provide coverage over the full disk to attempt to meet 10 km spatial resolution, 60 minute refresh rate, with 5 cm vertical resolution, with a measurement range of 0-100% of a pixel, with a measurement accuracy of n/a, 5 km mapping accuracy, and 6 hour data latency need. The following details the threshold requirement for the Flood Standing Water--Hemispheric: full disk coverage, 10 km spatial

resolution, 60 minute refresh rate, with requested 5 cm vertical resolution, with a measurement range of 0-100% of a pixel, with a measurement accuracy of n/a, 5 km mapping accuracy, and 6 hour data latency.

ID:
1144

ABI will *contribute to* determinations of Flood Standing Water--Mesoscale on the land. ABI will provide coverage over the full disk to attempt to meet 10 km spatial resolution, 60 minute refresh rate, with 5 cm vertical resolution, with a measurement range of 0-100% of a pixel, 5 km mapping accuracy, and 6 hour data latency need. The following details the threshold requirement for the Flood Standing Water--Mesoscale: mesoscale coverage, 10 km spatial resolution, 60 minute refresh rate, with requested 5 cm vertical resolution, with a measurement range of 0-100% of a pixel, 5 km mapping accuracy, and 6 hour data latency.

ID:
1145

ABI will *contribute to* determinations of Ice cover /Landlocked (on the land). ABI will provide coverage over the full disk to attempt to meet TBD spatial resolution, with n/a vertical resolution, 3 hour refresh rate, with a measurement range of TBD, measurement accuracy of TBD, TBD mapping accuracy, and TBD data latency need. The following details the threshold requirements and for the Ice cover /Landlocked: full disk coverage TBD spatial resolution, with n/a vertical resolution, 3 hour refresh rate, with a measurement range of TBD, measurement accuracy of TBD, TBD mapping accuracy, and TBD data latency.

ID:
1146

ABI will *measure* Land Surface (Skin) Temperature--CONUS on the land. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, 5 minute refresh rate, with a measurement range of 233-333 K and measurement accuracy of 1.0 K, 1 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Land Surface (Skin) Temperature--CONUS: CONUS coverage, 2 km spatial resolution, 60 minute refresh rate, with a measurement range of 233-333 K and measurement accuracy of 1.0 K, 1 km mapping accuracy, and 60 minute data latency.

ID:
1147

ABI will *measure* Land Surface (Skin) Temperature--Hemisphere on the land. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, with a measurement range of 233-333 K and measurement accuracy of 1 K, 1 km mapping accuracy, and 3 minute data latency need. The following details the threshold requirement for the Land Surface (Skin) Temperature--Hemispheric: full disk coverage, 2 km spatial resolution, 60 minute refresh rate, with a measurement range of 233-333 K and measurement accuracy of 1 K, 1 km mapping accuracy, and 3 minute data latency.

ID:
1148

ABI will *measure* Land Surface (Skin) Temperature--Mesoscale on the land. ABI will provide coverage over the mesoscale to meet 2 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, with a measurement range of 213-333 K and measurement accuracy of 1.0 K, 1 km mapping accuracy, and 3 minute data latency need. The following details the threshold requirement for the Land Surface (Skin) Temperature--Mesoscale: mesoscale coverage, 2 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, with a measurement range of 213-333 K and measurement accuracy of 1.0 K, 1 km mapping accuracy, and 3 minute data latency.

ID:
1150
ABI will *contribute to* determinations of Snow Cover--CONUS on the land. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, with n/a vertical resolution, 5 minute refresh rate, with a measurement range of binary (yes/no) and measurement accuracy yes/no detection, 1 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Snow Cover--CONUS: CONUS coverage, 2 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, with a measurement range of binary (yes/no) and measurement accuracy yes/no detection, 1 km mapping accuracy, and 60 minute data latency.

ID:
1151
ABI will *contribute to* determinations of Snow Cover--Hemisphere on the land. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, with a measurement range of binary (yes/no) and measurement accuracy yes/no detection, 1 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Snow Cover--Hemispheric: full disk coverage, 2 km spatial resolution, 60 minute refresh rate, with a measurement range of binary (yes/no) and measurement accuracy yes/no detection, 1 km mapping accuracy, and 60 minute data latency.

ID:
1152
ABI will *contribute to* determinations of Snow Cover--Mesoscale on the land. ABI will provide coverage over the mesoscale to meet 2 km spatial resolution, 30 second refresh rate, with a measurement range of binary (yes/no) and measurement accuracy of yes/no detection, 1 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Snow Cover--Mesoscale: mesoscale coverage, 2 km spatial resolution, 60 minute refresh rate, with a measurement range of binary (yes/no) and measurement accuracy of yes/no detection, 1 km mapping accuracy, and 60 minute data latency need.

ID:
1153
ABI will *contribute to* determinations of Snow Depth-Plains only--CONUS on the land. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, 5 minute refresh rate, with a measurement range of TBD, measurement accuracy of TBD, 1 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Snow Depth-Plains only--CONUS: CONUS coverage, 2 km spatial resolution, 60 minute refresh rate, with a measurement range of TBD, measurement accuracy of TBD, 1 km mapping accuracy, and 60 minute data latency need.

ID:

1154

ABI will *contribute to* determinations of Snow Depth-Plains only--Hemisphere on the land. ABI will provide coverage over the full disk to meet 2 km spatial resolution, 15 minute refresh rate, with a measurement range of TBD, measurement accuracy of TBD, 1 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Snow Depth-Plains only: Hemispheric: full disk coverage, 2 km spatial resolution, 60 minute refresh rate, with a measurement range of TBD, measurement accuracy of TBD, 1 km mapping accuracy, and 60 minute data latency need.

ID:

1155

ABI will *contribute to* determinations of Snow Depth-Plains only--Mesoscale on the land. ABI will provide coverage over the mesoscale to meet 2 km spatial resolution, 30 sec refresh rate, with a measurement range of TBD, measurement accuracy of TBS, 1 km mapping accuracy, and TBD data latency need. The following details the threshold requirement for the Snow Depth-Plains only--Mesoscale: 2 km spatial resolution, TBD refresh rate, with a measurement range of TBD, measurement accuracy of TBS, 1 km mapping accuracy, and TBD data latency.

ID:

1156

ABI will *contribute to* determinations of Surface Albedo--Hemisphere on the land. ABI will provide coverage over the full disk to meet 2 km spatial resolution, with n/a vertical resolution, 15 minutes refresh rate, with a measurement range of 0-1 albedo units, a measurement accuracy of TBD, 1 km mapping accuracy, and TBD data latency need. The following details the threshold requirement for the Surface Albedo--Hemispheric: full disk coverage, TBD spatial resolution, with n/a vertical resolution, TBD refresh rate, with a measurement range of 0-1 albedo units, a measurement accuracy of TBD, TBD mapping accuracy, and TBD data latency.

ID:

1157

ABI will *contribute to* determinations of Surface Emissivity--CONUS on the land. ABI will provide coverage over the CONUS to meet 10 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, with a measurement range of 0.85-1.0 albedo units, measurement accuracy of 0.05 albedo units, 5 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Surface Emissivity--CONUS: CONUS coverage, 10 km spatial resolution, with n/a vertical resolution, 60 minute refresh rate, with a measurement range of 0.85-1.0 albedo units, measurement accuracy of 0.05 albedo units, 5 km mapping accuracy, and 60 minute data latency.

ID:

1158

ABI will *contribute to* determinations of Vegetation Fraction--Green on the land. ABI provides coverage over the CONUS to meet 2 km spatial resolution, 15 minute refresh rate, with a measurement range of 0-1 (unitless)and measurement accuracy of 0.05, 1 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Vegetation Fraction--Green: CONUS

coverage, 2 km spatial resolution, 60 minute refresh rate, with a measurement range of 0-1 (unitless) and measurement accuracy of 0.05, 1 km mapping accuracy, and 60 minute data latency need.

ID:
1159

ABI will *contribute to* determinations of Vegetation Index--CONUS on the land. ABI will provide coverage over the CONUS to meet 2 km spatial resolution, 5 minute refresh rate, with a measurement range of 0-1 NDVI units, measurement accuracy of 0.04 NDVI units, 1 km mapping accuracy, and 60 minute data latency need. The following details the threshold requirement for the Vegetation Index---CONUS: CONUS coverage, 2 km spatial resolution, 60 minute refresh rate, with a measurement range of 0-1 NDVI units, measurement accuracy of 0.04 NDVI units, 1 km mapping accuracy, and 60 minute data latency.

ID:
1161

ABI will contribute to determinations of the **Currents--Hemispheric**. ABI will provide coverage over the full disk to meet the threshold 6 hours refresh; at the surface, with a 60 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 5 m/sec (0 - 18 km/hour) (direction 0 to 360 degrees); and with 1.0 km/hour accuracy. The following details the threshold requirement for the Currents--Hemispheric: over the full disk; with a threshold 6 hours refresh; at the surface, with a 60 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 5 m/sec (0 - 18 km/hour) (direction 0 to 360 degrees); and with 1.0 km/hour accuracy.

ID:
1162

ABI will contribute to determinations of the **Currents--Mesoscale.** ABI will provide coverage over the mesoscale in the coastal region of 1000 km x 400 km to meet a threshold 6 hours refresh; with 15 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 5 m/sec (0 - 18 km/hour); and with 1.0 km/hour accuracy. The following details the threshold requirement for the Currents--Mesoscale: over the mesoscale in the coastal region of 1000 km x 400 km; with a threshold 6 hours refresh; with a 60 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 5 m/sec (0 - 18 km/hour); and with 1.0 km/hour accuracy.

ID:
1163

ABI will contribute to determinations of the Currents---Offshore/CONUS. ABI will provide coverage over the CONUS and CONUS EEZ to address a threshold < 6 hours refresh; with n/a vertical resolution; with a 180 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0-5 m/s (0-18 km/hour); and with 2.0 m/s accuracy, and 60 minute latency. The following details the threshold requirement for the Currents---Offshore/CONUS over the CONUS and CONUS EEZ; with a threshold 6 hours refresh; with n/a vertical resolution; with a 180 minute threshold latency; at 2 km threshold resolution by using the

radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0-5 m/s (0-18 km/hour); and with 2.0 m/s accuracy, and 60 minute latency.

ID:
1164

ABI will contribute to determinations of the Currents--Hemispheric. ABI will provide coverage over the full disk to address TBD spatial resolution; with n/a vertical resolution; with a threshold TBD minute refresh; with a TBD minute threshold latency; at TBD km threshold resolution by using the radiance values; using TBD km threshold mapping uncertainty; and with +/- TBD accuracy. The following details the threshold requirement for the Currents--Hemispheric: over the full disk; with TBD spatial resolution; with n/a vertical resolution; with a threshold TBD minute refresh; with a TBD minute threshold latency; at TBD km threshold resolution by using the radiance values; using TBD km threshold mapping uncertainty; and with +/- TBD accuracy.

ID:
1165
Removed

ID:
1166
ABI will contribute to determinations of **Sea and Lake Ice Age--Hemispheric.** ABI will provide coverage over the full disk to meet with a threshold < 6 hour refresh; with a < 60 minute threshold latency; at < 3 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; over the measurement range of distinguishing between ice free areas and first year ice with 90% measurement accuracy. The following details the threshold requirement for the Sea and Lake Ice/Age--Hemispheric: over the full disk, with a threshold 6 hours refresh; with a 60 minute threshold latency; at 3 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; over the measurement range of distinguishing between ice free areas and first year ice with 90% measurement accuracy.

ID:
1167
ABI will contribute to determinations of **Sea and Lake Ice Concentration--CONUS.** ABI will provide coverage over the CONUS coastal water containing sea ice to meet with a threshold 180 minute refresh; with a 60 minute threshold latency; at < 3 km threshold resolution by using the radiance values; using < or = 1.5 km threshold mapping uncertainty; over the range 0/10 to 10/10 for a measurement accuracy of ice extent of 1 km and ice concentration of 10%. The following details the threshold requirement for the Sea and Lake Ice Concentration--CONUS: coverage of CONUS coastal waters containing sea ice, with a threshold 180 minute refresh; with a 60 minute threshold latency; at 3 km threshold resolution by using the radiance values; using < or = 1.5 km threshold mapping uncertainty; over the range 0/10 to 10/10 for a measurement accuracy of ice extent of 1 km and ice concentration of 10%.

ID:
1168
ABI will contribute to determinations of **Sea and Lake Ice Concentration--Hemispheric.** ABI will provide coverage over the full disk water containing sea ice to meet with a threshold 6 hour refresh; with

a 60 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; over the measurement range of ice concentration of 0/10 to 10/10 for a measurement accuracy of ice extent 1 km and ice concentration of 10%. The following details the threshold requirement for the Sea and Lake Ice Concentration--Hemispheric: over the range of ice the full disk water containing sea ice, with a threshold 6 hour refresh; with a 60 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; concentration of 0/10 to 10/10 for a measurement accuracy of ice extent 1 km and ice concentration of 10%.

ID:
1170
ABI will contribute to determinations of **Sea and Lake Ice Displacement and Direction--Hemispheric.** ABI will provide coverage over the full disk water containing sea ice to meet a threshold 180 minute refresh; with a 60 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 10 km threshold mapping uncertainty; over the range of TBD and for a measurement accuracy of +/- 22.5 degrees. The following details the threshold requirement for the Sea and Lake Ice Displacement and Direction--Hemispheric: over the full disk water containing sea ice, with a threshold 180 minute refresh; with a 60 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 10 km threshold mapping uncertainty; over the range of TBD and for a measurement accuracy of +/- 22.5 degrees.

ID:
1172
ABI will contribute to determinations of **Sea and Lake Ice Extent and Edge--Hemispheric.** ABI will provide coverage over the full disk water containing sea ice to meet a 6 hour refresh, 180 minute latency, at 0.5 km spatial resolution, using < 0.5 km mapping accuracy, detecting presence of ice in the daytime using radiance values, and 10% measurement accuracy. The following details of the threshold requirement for the Sea and Lake Ice Extent and Edge--Hemispheric: covering the full disk water containing sea ice, with 6 hour refresh, 180 minute latency, at 0.5 km spatial resolution, using < 0.5 km mapping accuracy, detecting presence of ice in the daytime using radiance values, and 10% measurement accuracy.

ID:
6363
ABI will measure **Sea and Lake Ice Motion--CONUS**. ABI will provide inputs from coverage over the Great Lakes and Chesapeake Bay and Delaware Bay with a threshold 5 minute refresh; with a 60 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; for a measurement range for direction of 0 - 360 degrees and for final product displacement of 0 - 0.6 m/s, and for final product accuracy on direction of + / - 15 degrees. The following details the threshold requirement for the **Sea and Lake Ice Motion--CONUS:** over the Great Lakes and Chesapeake Bay and Delaware Bay with a threshold 180 minute refresh; with a 60 minute threshold latency; at 5 km threshold resolution by using the radiance values; using < / = 2.5 km threshold mapping uncertainty; for a measurement range on Direction of 0 - 360 degrees and on displacement of 0 - 0.6 m/s, and for final product accuracy on direction of + / - 15 degrees.

ID:

1174

ABI will measure **Sea and Lake Ice Surface Temperature-Hemispheric.** ABI will provide coverage over the full disk water containing sea ice with a threshold 5 minute refresh; with a 60 minute threshold latency; at 2 km threshold resolution using 1.0 km threshold mapping uncertainty; for a measurement range of 213 - 280 K with 1.0 K measurement accuracy. The following details the threshold requirement for the Sea and Lake Ice Surface Temperature - Hemispheric: with a threshold 6 hour refresh; with a 180 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; for a measurement range of 213-280 K and a measurement accuracy of 1.0 K.

ID:

6365

ABI will measure **Sea and Lake Ice Motion--Hemispheric.** ABI will provide inputs from coverage over the full disk water containing sea ice with a threshold 5 minute refresh; with a 60 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; for a measurement range for direction of 0 - 360 degrees and for final product displacement of 0 - 0.6 m/s, and for final product accuracy on direction of + / - 15 degrees. The following details the threshold requirement for Sea and Lake Ice Motion--Hemispheric: coverage over the full disk water containing sea ice, with a threshold 6 hour refresh; with a 180 minute threshold latency; at 15 km threshold resolution by using the radiance values; using < / = 7.5 km threshold mapping uncertainty; for a measurement range on Direction of 0 - 360 degrees and on displacement of 0 - 0.6 m/s, and a measurement accuracy on direction of + / - 15 degrees.

ID:

1175

Removed

ID:

1176

ABI will measure **Sea Surface Temperature--CONUS/Offshore.** ABI will provide with a threshold 5 minute refresh; with a 5 minute threshold latency; at 2 km threshold resolution; using 1.0 km threshold mapping uncertainty; for a measurement range of 270-313 K and a measurement accuracy of 1.0 K. The following details the threshold requirement for the Sea Surface Temperature--CONUS/Offshore: with a threshold 180 minute refresh; with a 60 minute threshold latency; at 2 km threshold resolution; using 1 km threshold mapping uncertainty; for a measurement range of 270-313 K and a measurement accuracy of 1.0 K.

ID:

1177

ABI will measure **Sea Surface Temperature--Hemispheric.** ABI will provide full disk coverage with a threshold 5 minute refresh; with a 5 minute threshold latency; at 2 km threshold resolution; using 1.0 km threshold mapping uncertainty; for a measurement range of 270-313 K and a measurement accuracy of 1.0 K. The following details the threshold requirement for the Sea Surface Temperature--Hemispheric: coverage of the full disk, 180 minute refresh; with a 60 minute threshold latency; at 2 km threshold resolution; using 1.0 km threshold mapping uncertainty; for a measurement range of 270-313 K and a measurement accuracy of 1.0 K.

ID:
1178
ABI will measure **Sea Surface Temperature--Mesoscale.** ABI will provide mesoscale coverage with a threshold 15 minute refresh for all mesoscales (30 seconds for one mesoscale); with a 15 minute threshold latency; at 2 km threshold resolution; using 1.0 km threshold mapping uncertainty; for a measurement range of 271-313 K and a measurement accuracy of 1.0 K. The following details the threshold requirement for the Sea Surface Temperature--Mesoscale: mesoscale coverage, with a threshold 60 minute refresh; with a 15 min threshold latency; at 2 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; for a measurement range of 270-313 K, and a measurement accuracy of 1 K.

ID:
1179

(2.10.1) 3A. Top Priority Requirements

ID:
1180
The following four requirements are considered to be the highest priority by NOAA's National Weather Service for the imager:

ID:
1181
(2.10.1) 3.A.1. Operation during eclipse and keep out zone periods

ID:
1182
The imager shall be capable of continuous operation during eclipse periods in geostationary orbit.

ID:
1183
Such imaging shall include acquisition of data from all bands with wavelengths greater than 3 um, and if necessary, support of navigation through the ability to observe stars in the visible range. Bands with wavelengths greater than 3 um shall meet all requirements, although there is a relaxed navigation specification described in section (2.10.1) 3.B.3.

ID:
1184
During the daily period of time prior to and following spacecraft eclipse, and during the seasonal periods just prior to and after eclipse when sunlight impinges on the imager optical path (defined by NOAA as the keep-out-zone period), the ABI shall not acquire data within 3 degrees of the sun (5 degrees for the 3.9 um band).

Discussion: Formulation studies have determined that this is the region that provides acceptable performance as defined by NOAA.

For all pixels in the annulus between 3 degrees (5 degrees for the 3.9 um band) and 7.5 degrees of the center of the sun for all spectral bands except the low light band (which is excepted out to 10 degrees), the ABI shall perform as follows:

ID:
1185
.

ID:
1186
Emitted bands shall have NEdTs no more than two times values shown in Table 3a and radiometric accuracy better than 2 degrees K.

ID:
1187
No bands shall saturate on the supplied signal level.

ID:
1188
Signal to noise, Modulation Transfer Function, Image Navigation and Registration, and Calibration Accuracy requirements for the Visible, and Reflected Solar < 3 um bands shall not apply whenever any point on the earth falls within the annulus specified above.

ID:
5871
Thus, the ABI shall meet all operational requirements (except for low light channel requirements) for all pixels outside of the 7.5-degree radius and all operation requirements for all pixels outside of the 10 degree radius from the center of the sun.

ID:
1189
Discussion: See paragraph 2.B.11 "Avoidance of Imager Damage Due to Sunlight", a relating requirement and discussion.

ID:
1190
Discussion: Geostationary viewing geometry results in sunlight impingement on the optical path of the GOES imaging telescope during the periods of the year several weeks around each equinox. When this happens, stray sunlight may cause a degradation of the radiometric response accuracy of the imager's Earth-viewing detectors, as well as heating of the optical and structural elements of the instrument (e.g. the secondary mirror mounts). How much degradation and how long this effect lasts will depend on many design features of the imager. The imager should be designed in such a way that intrusion of sunlight from outside the field of view is minimized, reducing as much as is practical the need for "keep-out-zones" near local midnight during the equinoxes, and in addition minimize heating of secondary mirror and mount. Focused sunlight on the optics is a cause of potential damage. The energy is

sufficient to damage optical materials and coatings, and to irreparably damage detectors. Within 3 degrees it would not be useful to take data. The relaxation of requirements between 3 (5 degrees for 3.9 um) and 7.5 degrees (10 degrees for the low light channel) of the sun is done in recognition that stray light will contribute noise in the local midnight condition. These numbers are the result of formulation studies.

ID:
1191

Benefits: Providing near-continuous coverage through the spring and fall eclipse and keep-out-zone periods will give needed IR data of both spring severe weather and hurricanes.

ID:
1192

(2.10.1) 3.A. 2.   Meet "simultaneous" global/synoptic/mesoscale imaging needs.

ID:
1193

The imager shall be capable of acquiring images over the contiguous United States (CONUS) in a duty cycle that does not prohibit acquiring images of the full Earth disk as seen from geostationary orbit "simultaneously", in accordance with temporal resolution requirements given in Top Priority Requirement #3 (2.10.2) 3.A.3, below.

ID:
1194

Discussion: Previous GOES imaging systems were incapable of acquiring images below the equator when rapid-interval scanning of the CONUS for severe weather surveillance was invoked; nor capable of performing the required number of full disk and CONUS updates.

ID:
1195

Benefits: Retaining the regular southern hemispheric observations are advantageous to cloud motion analyses for numerical weather prediction, and for monitoring of volcanoes and synoptic-scale weather systems affecting US aviation and marine operations.

ID:
1196

(2.10.1) 3.A.3. Improve the temporal resolution of the imager.

ID:
1197

The imager shall be capable of acquiring data of a given area in both of the following time scales, although scan mode 4 is anticipated to be the normal operation mode:

ID:
1198

a) Scan mode 3: Full Earth disk (stepped-edge acceptable) every 15-minutes; plus CONUS, or the equivalent of a nadir-viewed rectangle 5000 kilometers by 3000 kilometers in dimension, every 5 minutes and at least one 1000 by 1000 kilometer area (nadir) every 30 seconds.

ID:
1199

ID:
1200
b) Scan mode 4: Full Earth disk (stepped-edge acceptable) every 5-minutes.

ID:
1201
c) The CONUS and full disk imaging shall be done concurrently with all other image activities, such as space looks, blackbody calibrations and any necessary star observations.

ID:
1202
d) The ABI image acquisition control system shall be flexible such that different observational regions and timing can be easily commanded from the NOAA-NESDIS SOCC within the general limitations of the scan rate, buffers and data rate limits of the system.

ID:
1203

ID:
1204
Discussion: NOAA will use routine five-minute image refresh for US forecast and warning missions. However, the imager shall have the capability to cover an area of at least 1000 by 1000 kilometers (as measured at nadir) in less than 30 seconds in order to provide non-routine, mesoscale surveillance of any atmospheric, oceanic, or terrestrial event that may benefit by more rapid updates.

ID:
1205
Benefits: An improved temporal resolution allows more frequent updates of the CONUS and full disk, as well as monitoring rapidly changing mesoscale events.

ID:
1206
(2.10.1) 3.A.4. Improve spatial resolution of the imager data.

ID:

1207

The imager shall produce data with the following resolution, as measured at SSP:

ID:
1208
The baseline visible band (0.64 µm) resolution shall be 0.5 km at the SSP but the exact value will be determined during the ABI formulation.

ID:
1209
   a) The spatial resolution of the 0.47 um, 0.86 um, and 1.61 um bands shall be 1.0 km at the SSP.

ID:
1210
        b) All other bands shall have a resolution of 2.0 km at the SSP.

ID:
1211
c) The emissive bands shall all be of the same resolution, as defined after the discussion below.

ID:
1212
Discussion: The intent of the NWS resolution requirement is to double the current GOES imager resolution to allow for better identification and tracking of cloud and moisture signatures that indicate the development of severe weather.   To assure that the ABI resolution is twice that of the current imager, the requirement is defined using the instrument's system Modulation Transfer Function (MTF). MIT - Lincoln Laboratory analyses have demonstrated (and formulation has validated) that by extending the MTF specification used for the GOES I-M series imager to twice the spatial frequency, the requirement for higher resolution can be achieved. Specifying the system MTF also allows for flexibility in the design of subsystems.

ID:
1213
The MTF (i.e. resolution) system requirements of Table 1a and Table 1b shall be met by the level 1b product (after resampling). MTF between solar reflective bands should be similar to reduce artifacts in multi-band products. Similarly, MTF between emissive bands should be similar to reduce artifacts in multi-band products.
Discussion: Table 1a describes the MTF requirements for the 2.0 km bands emissive IR bands. Table 1b describes the MTF requirements for all of the 0.5 and 1.0 km bands and the reflective solar 2.0 km bands. The maximum visible spatial frequency to be measured is 1 km^{-1} or 1 km/cycle. The maximum emissive IR spatial frequency to be measured is 0.25 km^{-1} or 4.0 km/cycle.
The MTF requirement shall apply to both E/W and N/S directions after any ground processing.

ID:
1214
Table 1a.   MTF Requirements for ABI Emissive IR, 2.0 km bands

Spatial Period (km/cyc)	Spatial Frequency (cyc/rad)	System MTF
16.0	2250	0.84
8.0	4500	0.62
5.333	6750	0.39
4.0	9000	0.22

ID:
1236

Table 1b. MTF Requirements for ABI Reflective solar bands yielding 0.5 km, 1.0 km bands, and 2 km resolution.

0.64 micron channel (0.5 km)			0.47, 0.86, 1.61 micron channels (1.0 km)			1.38 and 2.26 channels		
Spatial Period km/cyc	Spatial Frequency cyc/rad	System MTF	Spatial Period km/cyc	Spatial Frequency cyc/rad	System MTF	Spatial Period km/cyc	Spatial Frequency cyc/rad	System MTF
4.0	9000	0.90	8.0	4500	0.90	16.0	2250	0.90
2.0	18000	0.73	4.0	9000	0.73	8.0	4500	0.73
1.333	27000	0.53	2.666	13500	0.53	5.333	6750	0.53
1.0	36000	0.32	2.0	18000	0.32	4.0	9000	0.32

ID:
1302

ID:
1303

Discussion: This requirement also represents the technical interpretation of the NWS ORD requirement on "image smearing," as stated in the 1999 NWS ORD, page 11, 12. The actual NWS ORD value of requiring 99.5% of true radiance for any field-of-view to be achieved within 3 pixels has been dropped.

ID:
1304

Benefits: Increasing the spatial resolution allows for identification of smaller scale phenomena, for example: outflow boundaries, cloud-top thermal gradients and fog.

ID:
1305

(2.10.1) 3.B. Additional Imager Requirements

ID:
1306

This section details the remainder of the technical requirements derived from the GPRD-1, the NWS ORD, and from NOAA-NESDIS.

All navigation accuracies shall be **3 sigma** values.

ID:
1307

Table 2. ABI Requirement Summary (Partial List) *(Provided for reference only)*

Requirement Name and Source		Requirement Values
Spatial resolution and uniformity	Visible (0.64 µm band)	0.5 km (14 µrad)
	0.47 um, 0.86 um, and 1.61 um bands	1.0 km (28 urad)
	1.38 um and all bands > 2 um	2 km (56 µrad) (Table 1)
Spatial coverage	Full disk	Scan mode 4: 12 per hour Scan mode 3: 4 per hour
	CONUS (3000 x 5000 km)	Scan mode 4: no additional CONUSs Scan mode 3: 12 per hour
	Mesoscale (1000 x 1000 km) when required	Scan Mode 4: no additional mesoscales Scan mode 3: Every 30 sec
Operation during eclipse		Yes
Simultaneity		Within 5 sec. for all bands at any FOV Within 30 sec. for any adjacent (N/S) pixels Within 15 sec. for any adjacent (E/W) pixels
Number of bands		16
Spectral bands, Radiometric Sensitivity, Dynamic Range		(Table 3)
Navigation (pre-margining)		</ = 1.0 km (</ = 28 µrad) (see sec 2.10.1) 3.B.3
Registration within		</ = 1.0 km (</ = 28 µrad) (see sec 2.10.1) 3.B.6

frame (pre-margining)		
Line-to-line registration (pre-margining)		</= 0.25 km (at SSP) or </= 7 urad (see sec 2.10.1) 3.B.6
Registration image to image (pre-margining)		</= 0.75 km (at SSP) or </= 21 urad for 0.5 km bands and 1.0 km bands (see sec 2.10.1) 3.B.8 </= 1.0 km (at SSP) or 28 urad for 2.0 km bands (see sec 2.10.1) 3.B.8
Band to band co-registration (pre-margining)	0.5 km bands to 2.0 km bands	</= 0.3 km (at SSP) or </= 8.4 urad
	2.0 km bands to 2.0 km bands	</= 0.3 km (at SSP) or </= 8.4 urad
	0.5 km bands to 1.0 km bands	</= 0.3 km (at SSP) or </= 7 urad
	1.0 km bands to 1.0 km bands	</= 0.25 km (at SSP) or </= 7 urad
	1.0 km bands to 2.0 km bands	</= 0.3 km (at SSP) or </= 8.4 urad
On-orbit calibration	Visible and reflected solar < 3 um	Pre-launch to ± 5% On-board to ± 3% 0.2% short-term repeatability
	Emissive IR	0.2 K repeatability 1.0 K abs. Accuracy
IR band linearity		± 1%
Lifetime***	Ground storage	5 years (TBR)
	On-orbit storage	5 years (TBR) is max possible
	Mean Mission	8.4 years (see section (2.10.1) 3.B.1 (TBR) years

	Duration (MMD)	
	Instrument On life	10 years with R=0.6 (see section (2.10.1) 3.B.1)

ID:
1422

(2.10.1) 3.B.1   Lifetime:

ID:
1423

The instrument shall be designed for an 8.4 year Mean Mission Duration (MMD) at the end of 10 years. The MMD is the integrated area under the instrument reliability versus time curve from t = 5 years to t = 15 years, divided by the reliability estimated at 5 years.

Discussion: This mean that a 10-year instrument-on life shall be supported with Reliability (R) of 0.6.

ID:
1424

Discussion: NOAA-NESDIS studied the benefits of extending the present lifetime of the current GOES series, as well as issues associated with extending the lifetime as a way to contain and reduce program costs. Given that new instruments are required to meet NOAA requirements as well as provide replacements and new designs, it was timely to look at the longer life. However, long life may be traded against the insertion of new capabilities and/or technologies. Major long lifetime issues would be: Avoiding single point failure designs, long life evaluation through accelerated lifetime testing of selected components such as mechanisms, thermal control of optics and electronics, analyses such as FMECA (Failure Mode, Effects and Criticality Analysis).

ID:
1425

Benefits: Extending the lifetime will save money by reducing program costs.

ID:
1426

(2.10.1) 3.B.2.   Types of observations and accuracies:

ID:
1427

To enable the generation of meteorological and environmental products needed for operational NWS uses, ABI shall yield observations according to the following table of bands, defined by center wavelength and bandwidth, measurement ranges, maximum radiances, and noise. In addition, ABI shall support navigation.

Discussion: If star sensing in the visible down the optical path of the instrument is employed to support navigation, star sensitivity may permit four (4) stars to be observed at least 95% of the time and 1 star at all times.

Table 3: ABI Band Descriptions

Table 3a. Radiometric Sensitivity and Dynamic Range

Wavelength (µm)	NEdT @300K (K)	NEdT @240K (K)	NEdN, or SNR at 100% albedo (mW/m^2/sr/cm^{-1})	Tmin (K)	Tmax (K)	Rmax (mW/m^2/sr/ cm^{-1})	Rmax/ NEdN
0.47 +/- 0.02	-	-	300:1	N/A	-	14.4	-
0.64 +/- 0.05	-	-	300:1	N/A	-	21.1 (day) 1.05 (night)	-
0.86 +/- 0.02	-	-	300:1	N/A	-	22.8	-
1.38 +/- 0.015	-	-	Now 300:1	N/A	-	21.7	-
1.61 +/- 0.03	-	-	300:1	N/A	-	20.0	-
2.26 +/- 0.025	-	-	300:1	N/A	-	12.1	-
3.9 +/- 0.1	0.10	1.4	0.004	4	400	19.7	4925
6.185 +/- 0.415	0.10	0.4	0.05	4	300	21	420
6.95 +/- 0.2	0.10	0.37	0.09	4	300	37	411
7.34 +/- 0.1	0.10	0.32		4	320	67.3	
8.5 +/- 0.2	0.10	0.27	0.13	4	330	116	892
9.61 +/- 0.19	0.10	0.22		4	300	93.2	
10.35 +/- 0.25	0.10	0.21	0.17	4	330	161	947
11.2 +/- 0.4	0.10	0.19	0.17	4	330	176	1035
12.3 +/- 0.5	0.10	0.18	0.18	4	330	190	1118
13.3 +/- 0.3	0.30	0.48	0.53	4	305	150	283

Discussion: For the ABI, both visible and "visible" refer to the band with a center wavelength near 0.64 um. The reflected solar bands with wavelengths < 3 um refers to all bands with center wavelength's between 0.47 um and 3.0 um, except for the "visible" band just defined.

The maximum temperature for each band shall be at least what is specified in the above table through out the lifetime of the instrument. Also, for calibration purposes, all IR bands shall not saturate below the maximum expected blackbody temperature. The NEdT requirements must be met even at end of life.

ID:
1587
Due to the increased spatial resolution of the ABI, the temperature maximum for the 3.9 µm band shall be at least 375 K to maintain the current (GOES-8 and GOES-M and beyond) fire detection capability. *Discussion: The NEdT requirement is relaxed (although less than 0.5 K) for scene temperatures greater than 330 K. GOES is the only platform that can adequately sample the important temporal aspect of the majority of fires. The identification of fires is a NWS requirement. The 375 K temperature value must allow for adequate signal quantization. As a result of studies, the chosen temperature value is 400 K.*

ID:
1588
   Benefits: The selection of bands has been optimized to meet all cloud, moisture, and surface observations requirements to support the NWS mission of weather and other forecasting.
The phenomena observed and the critical applications are described by band:

ID:
1589
a)   0.47 um band: Daytime aerosol-on-land/coastal water mapping

ID:
1590
b) Visible (0.64 µm band): Daytime cloud imaging; snow and ice cover; severe weather onset detection; low-level cloud drift winds; fog; smoke; volcanic ash; flash flood analyses, hurricane analysis; winter storm analysis

ID:
1591
c) .86 µm: Provides synergy with the AVHRR/3, as the band is similar to band 2 on AVHRR/3. This band is used for determining vegetation amount, aerosols and ocean/land studies. Characterizing aerosols and their optical properties is essential for improving a number of satellite products, for example SST, ocean color and surface temperatures. This band also enables very localized vegetation stress monitoring, fire danger monitoring, and albedo retrieval.

ID:
1592
d) 1.38 µm: Similar to a band on MODIS that sees into the lower troposphere due to water vapor sensitivity and thus it provides excellent daytime sensitivity to very thin cirrus. This will aid several products relying on clear skies in the infrared windows, for example SST. CIMSS work with MODIS data in this band has indicated that out of band signal contamination of 0.5% compared to the signal in this band threatens the quality of this product and thus 0.25% out of band signal contamination shall not be exceeded. Out of band contamination for all other bands shall not exceed the 1.0% level.

ID:
1593

e) 1.61 µm: Daytime cloud/snow/ice discrimination; total cloud cover; aviation weather analyses for icing; smoke from low-burn-rate fires

ID:
1594

f) 2.26 um: Daytime land/cloud properties, particle size, and vegetation

ID:
1595

g) 3.9 µm: Fog and low-cloud discrimination at night; fire identification; volcanic eruption and ash; daytime reflectivity for snow/ice

ID:
1596

h) 6.185 µm: Upper-tropospheric water vapor tracking; jet stream identification; hurricane track forecasting; mid-latitude storm forecasting; severe weather analysis

ID:
1597

i) 6.95 µm: Middle-tropospheric water vapor tracking; mid-tropospheric flow tropical storm track prediction weather; winter storm analyses

ID:
1598

j) 7.34 um: Lower tropospheric water vapor tracking and SO_2 detection

ID:
1599

k) 8.5 µm: Allows for detection of volcanic cloud with sulfuric acid aerosols, thin cirrus in conjunction with the 11 um band and determination of cloud micro-physical properties with the 11.2 and 12.3 um bands. This includes a more accurate delineation of ice from water clouds during the day or night.

ID:
1600

l) 9.61 um: Total Ozone

ID:
1601

m) 10.35 µm: Allows for determination of micro-physical properties of clouds with the 11.2 and 12.3 um bands. This includes a more accurate determination of cloud particle size during the day or night.

ID:
1602

n) 11.2 µm: Continuous day/night cloud analyses for many general forecasting applications; precipitation estimates; severe weather analyses and prediction; cloud drift winds; hurricane strength and track analyses; cloud top heights; volcanic ash; fog (in multi-band products); winter storms; cloud phase/particle size (in multi-band products)

ID:
1603
o) 12.3 µm: Continuous cloud monitoring for numerous applications; low-level moisture; volcanic ash trajectories; cloud particle size (in multi-band products)

ID:
1604
p) 13.3 µm: Cloud top height assignments for cloud-drift winds; cloud products for ASOS supplement; tropopause delineation; cloud opacity

ID:
1605
Table 3.b. 16 CHANNEL IMAGER BAND DESCRIPTION

Wavelength Microns	Prior-ity	Upper and lower 50% response points (in microns)	Noise @ Ref.	Max. Level	Purpose
0.47	Core	0.45±0.01 - 0.49±0.01	300/1	100 %	Daytime aerosol-on-land/coastal water mapping
0.64	Core	0.59±0.01 - 0.69±0.01	300/1	100 %	Daytime clouds
0.86	Core	0.84±0.01 - 0.88±0.01	300/1	100 %	Daytime vegetation & aerosol-on-water
1.38	Core	1.365±0.005 - 1.395±0.005	300/1	100 %	Daytime cirrus cloud
1.61	Core	1.58±0.01 - 1.64±0.01	300/1	100 %	Daytime cloud water, snow
2.26	Core	2.235±0.01 - 2.285±0.01	300/1	100 %	Daytime land/cloud properties, particle size, vegetation
3.90	Core	3.80±0.05 - 4.00±0.05	0.1 K	400 K	sfc. & cloud/fog at night, fire
6.185	Core	5.77±0.03 - 6.6±0.03	0.1 K	300 K	high. water
6.95	Core	6.75±0.03 - 7.15±0.03	0.1 K	300 K	mid water
7.34	Core	7.24±0.02 - 7.44±0.02	0.1 K	320 K	low water & SO_2
8.5	Core	8.3±0.03 - 8.7±0.03	0.1 K	330 K	total water for stability, cloud phase, dust, SO_2
9.61	Core	9.42±0.02 - 9.8±0.03	0.1 K	300 K	total ozone
10.35	Core	10.1±0.1 - 10.6±0.1	0.1 K	330 K	sfc. & cloud
11.2	Core	10.8±0.1 - 11.6±0.1	0.1 K	330 K	total water for SST, clouds
12.3	Core	11.8±0.1 - 12.8±0.1	0.1 K	330 K	total water & ash, SST
13.3	Core	13.0±0.06 - 13.6±0.06	0.3 K	305 K	air temp & cloud heights and amounts

ID:

1726
Benefits: The improved spectral coverage enhances current products and affords new products.

ID:
1727
Discussion: It is NOAA's understanding that the signal quantization may be about 12 bit for the IR bands and about 14 bits for the 3.9 µm band.

ID:
1728
The dominant direction of instrument "scan" shall be in the East-West (or West-East) directions. To accommodate a possible Yaw flip, stepping shall be possible in both North to South and South to North directions.

ID:
1729
If the NEdT specifications for the IR window bands (8.5, 10.35, 11.2 and 12.3 µm) at 300 K are exceeded to the 0.05 K, then the quantization shall be of ½ of the NEdT to recover margin in the bands.

ID:
5885
The relative accuracy of each band shall be within the NEdN (1-sigma) for the following categories of relative error: a) swath to swath (where a swath is one traversal of the scan mirror in the east-west directions over the entire scene of interest), b) detector to detector, c) channel to channel, d) calibration to calibration.

Discussion: If the vendor exceeds this requirement, quantization of 1/3 of the NED N is considered sufficient.

ID:
5886
It is understood that the engineering solution will involve focal plane arrays and thus crosstalk effects and blooming effects may contribute to signal uncertainties in non-uniform scenes, such as broken bright clouds over a darker scene. Other sources of crosstalk in the ABI would yield unwanted signal increases. At a minimum, the crosstalk contribution from a full scale signal from a neighboring pixel shall be less than or equal to the derived NEdN in the relevant band.

ID:
1730

(2.10.1) 3.B.3.   Imager System navigation

ID:
1731
Imager System navigation (Earth location) errors shall not exceed 1.0 kilometer at the SSP (3-sigma), except during eclipse.   For up to a 4-hour period including the eclipse of the sun, the navigation shall be

relaxed to 1.5 km at the SSP or 42 urad. The phasing of the four hours relative to midnight will be recommended by the contractor. Image navigation refers to the precision to which the longitude and latitude of each pixel within an image can be determined. The determination of location and registration will be via the centroid of the spatial response of the pixel. (See also Additional Requirement #3B 6)

ID:
1732

ID:
1733
Discussion: NOAA is aware that several requirements, notably in navigation and registration, that are difficult to achieve by traditional means. Ground processing (see 3.C.1) will be required to meet these requirements. An oversampled IR ground sample distance, in both directions, is required to ensure radiometrically accurate 2-km resolution IR products (see 3.B.4). MIT-LL has looked at spatial sample rates necessary for accurate ground processing and found several potential benefits. A 1-km sample rate in the IR bands is close to the Nyquist frequency for the system MTF of Table 1 and the corresponding optics and detector sizes envisioned for ABI. Since the data are nearly Nyquist sampled, the imagery can be reconstructed to any sample spacing with little radiometric error.

ID:
1734
During formulation, vendor studies results were employed by the government to finalize the requirements listed above; it is important to note that these numbers have not been margined. This requirement shall be met by the entire imager system and employs sampling at finer spatial resolution than the product together with ground processing to provide the navigation performance listed above.

ID:
1735

ID:
1736
Benefits: Accurate navigation on all images is essential to accurate forecast product generation at NOAA. Accurately navigated imagery allows trouble-free merger with other data sources, improved knowledge of the location of surface-based features and provides higher forecaster confidence in image interpretation, especially in applications demanding image animation.

ID:
1737

(2.10.1) 3.B.4.   Data format

ID:
1738

The data format must allow integration of imager data with other NOAA and other coincident data sources. To facilitate data use and integration, the distributed, calibrated, navigated ABI data shall be rectified to a fixed grid. The grid is defined as the 'perfect' satellite projection from a given longitude and geostationary orbit, similar to the current GOES-N fixed grid. The distributed data samples shall have an angular separation of 14 microradians (visible, 0.64 um), 28 microradians (0.47 um, 0.86 um, and 1.61 um) and 56 microradians (1.38 um, all wavelengths longer than 2 um) in both the East/West and North/South dimensions.

ID:
1739
Discussion: Integrating geostationary imager data with other meteorological data, such as doppler radar (WSR-88D), numerical model output, and in situ observations from networks like ASOS, ACARS, and lightning detection sensors, is a critical capability of NWS forecast processes. Imager data format must be documented to allow for such integration.

ID:
1740
Benefits: In addition to data fusion, this regular, orthogonal coordinate system allows for consistent estimations of feature sizes, distances and motions.

ID:
1741

(2.10.1) 3.B.5.　Co-registration

ID:
1742
Co-registration errors between infrared imager bands having 2.0 km spatial resolution shall not exceed 0.3 km (at SSP) or 8.4 urad. This requirement is for the total imager system as described in Section 2.

ID:
1743
The co-registration error between each of the infrared imager bands having 2.0 km spatial resolution and the visible band (0.5 km) shall not exceed 0.3 km (at SSP) or 8.4 urad and shall be determined by centroiding a set of visible FOV's to determine a "mean" visible FOV equal in extent to the IR FOV.

ID:
1744
The co-registration error between each of the infrared imager bands having 2.0 km spatial resolution and the infrared imager bands having 1.0 km spatial resolution shall not exceed 0.3 km (at SSP) or 8.4 urad and shall be determined by centroiding a set of 2x2 visible FOV's to determine a "mean" visible FOV equal in extent to the IR FOV.

ID:
1745

The co-registration error between each of the infrared imager bands having 1.0 km spatial resolution and the infrared imager bands having 1.0 km spatial resolution shall not exceed 0.25 km (at SSP) or 7 urad.

ID:
1746

The co-registration error between each of the infrared imager bands having 1.0 km spatial resolution and the visible band (0.5 km) shall not exceed 0.3 km (at SSP) or 8.4 urad and shall be determined by centroiding a set of 4x4 visible FOV's to determine a "mean" visible FOV equal in extent to the IR FOV.

ID:
1747

Discussion: Co-registration error should be minimized the most for the important bands that can sense the rapidly changing surface (i.e. 8.5, 10.35, 11.2, 12.3, 13.3 µm). These co-registration errors reflect the results of vendor formulation studies and government review, but it is important to note that these are the pre-margining value.

ID:
1748

Benefits: The combination of two or more imager bands is often needed to generate secondary products for specific forecast applications. Nighttime fog, for instance, can be distinguished readily by differencing the short-wavelength and window IR bands in high spatial resolution images. Accurate co-registration of bands is essential to generation of radiometrically and geographically accurate high-resolution analyses.

ID:
1749

(2.10.1) 3.B.6.   Pixel-to-pixel registration within frame:

ID:
1750

Within an image in the same channel, any two pixels shall be separated by the known fixed distance to within 1.0 km at SSP, or 28 urad.

ID:
1751

Line-to-line registration. Any two adjacent lines or swaths, East/West and North/South, within an image shall be separated by the nominal distance to within 0.25 km at SSP, or 7 urad.

ID:
1752

Discussion: These requirements are intended to define the limits of acceptable within-image distortions but also reflect improvements as a result of vendor formulation trade studies. These numbers are pre-margining.

ID:
1753
Benefits: Measurement of feature size and distance, in addition to image quality, require accurate within frame and line-to-line registrations.

ID:
1754

(2.10.1) 3.B.7. Removed

ID:
1755

(2.10.1) 3.B.8. Frame-to-Frame Registration

ID:
1756
Frame to frame (or image to image) registration error is the difference in navigation error for any given pixel in two consecutive images within the same channel. The frame-to-frame registration shall be 21 urad for the channels with 0.5 km and 1.0 km spatial resolution. The frame-to-frame registration shall be 28 urad for the channels with 2.0 km spatial resolution.

ID:
1757

(2.10.1) 3.B.9. Data simultaneity:

ID:
1758
a)   Data from all imager bands obtained for any specific point on Earth shall be coincident within 5 seconds.

ID:
1759
b)   All adjacent detector samples in the N/S direction from any one band for any given image shall be observed within 30 seconds of each other.

ID:
1760
c) At least 99.5% of adjacent detector samples in the E/W direction from any one band for any given image shall be observed within 15 seconds of each other.

ID:
1761

Discussion: Part a) of this requirement is needed to ensure accurate interpretation of image applications that are based on comparison of images in different bands. Part b) is based on engineering assumptions that focal plane array detectors may be used in imager designs. Where line or area arrays are to be used in east-west scanning, the time gap between successive swaths must be minimized to avoid introducing artifacts across the swath boundaries in reconstructed images. The intent of Part c) is that once a set of lines has begun to be scanned, the scanning of those lines should be completed. (Formulation studies have shown that certain types of scan methods will produce a small number of E/W neighbors originating from different scan lines. This same effect also requires resampled pixels be generated from detector samples taken from the same swath.) To address this, NOAA has defined a requirement for the maximum allowable time of <u>adjacent</u> <u>pixel</u> <u>simultaneity</u>. If this time is too short, imager design ramifications may be serious. If this time is too long, (i.e., too lenient), then deformations may be observed in swath boundaries of images.

ID:
1762
Discussion: As stated in part b), above, NOAA's requirement for adjacent pixel simultaneity is now defined as at least 30 seconds for all scanning scenarios. In a worst case, where a motion of cloud features is along the scan axis, artifacts resulting from the delay between scanning sequential swaths will be greatest. The table below summarizes the apparent north-south shift of cloud fields, in pixels, that would result from northerly winds, using a 30-second pixel simultaneity specification:

ID:
1763

Apparent Shift Ratio (In 2-km infrared pixels)

ID:
1764

Resulting from 30-second scan-swath offset on notional ABI with east-west scanning

ID:
1765

Wind Speed (N)		Pixels offset, nadir	Pixels offset, 35N (at subpoint longitude)

ID:
1766

| 0 km/hr | 0 m/s | 0.00 | 0.00 |

ID:
1767

| 10 | 2.8 | 0.04 | 0.03 |

ID:
1768

| 25 | 6.9 | 0.10 | 0.07 |

50	13.8	0.21	0.14

100	27.8	0.42	0.28

200	55.6	0.83	0.56

These numbers demonstrate the rationality of NOAA's 30-second simultaneity requirement: For fast wind fields (around 200 km/hr or ~120mph) typically associated with jet-stream cirrus clouds, the maximum cross-swath deformation artifact will be less than one 2-kilometer pixel at nadir. Higher wind speeds do occur in jet cirrus, but rarely at lowest latitudes, and rarely blowing due north (or south), and rarely in excess of 260 km/hr

Benefits: Improved wind and image quality.

(2.10.1) 3.B.10.　　Full Operations:

The ABI shall achieve full operations within 1 hour following spacecraft maneuvers.

Discussion: Routine operations should not be re-established too quickly to endanger the health or safety of the instrument. The design should minimize degradation to navigation ability from sun exposure on the scan mirror and the rest of the imager.

Benefits: Excessive delays in resuming routine imaging operations following mandatory outages associated with maneuvers can threaten continuity of weather surveillance and result in degradation of forecasts of severe weather.

ID:
1778

(2.10.1) 3.B. 11. Avoidance of ABI Damage Due to Sunlight

ID:
1779

ABI shall be designed to prevent sunlight from damaging any part of the imager. ABI shall go into a safe mode when the instrument determines an at-risk situation or when the spacecraft instructs the instrument to self-protect.

ID:
1780

Discussion: Focused sunlight on the optics is a cause of potential damage. The energy is sufficient to damage optical materials and coatings, and to irreparably damage detectors, especially the IR detectors. Two sources of damage have been identified. The first is operational imaging when the sun is in the field of regard. The keep out zone addresses this. The second is when the spacecraft goes off of sun and earth lock either for routine or unplanned maneuver.

ID:
1781

(2.10.1) 3.B.12.   Reflected Solar calibration:

ID:
1782

a) The "Visible" band and the other reflected solar bands with wavelengths less than 3 um shall be calibrated prior to launch to provide albedo to an accuracy of ± 5% at maximum scene radiance. The bands shall be quantized in such a way that the signal will not saturate (high counts or low counts) over the life of the instrument and under worst-case conditions.

ID:
1783

b)   The ABI shall have an on-board calibration for "visible" and reflected solar < 3 um channels. On-board radiometric calibration shall provide:

ID:
1784

1. Absolute radiometric calibration accuracy of 3.0%

ID:
1785

2. Relative (one-sigma) calibration deviations (short-term repeatability) of 0.2%

ID:

1786
3. Drift in measured radiances, over the lifetime of the ABI, of 0.5%.

ID:
1787
      4. Radiance measurements in the reflected solar wavelength range shall be traceable to NIST standards. Traceability is defined as the property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties. (International Vocabulary of Basic and General Terms in Metrology, 1993; used by NIST. The Government assesses the vendors demonstrations of radiance traceability to NIST, which the vendor establishes through both 1) a measurement assurance program (an example of which is the purchasing of NIST sources (e.g., lamps, blackbodies) with adherence to specified recalibration schedules pre-launch), and 2) use of NIST best practices in radiance determinations, including quality programs detailing measurement procedures and reproducibility and using trained personnel.

ID:
5873
5. The solar reflectance bands < 3 um shall be adequately calibrated to ensure that the calibration requirements are met.
      Discussion: NOAA anticipates on-board calibration be performed at least once a month under routine operations and more frequently (e.g., once a day) during   post-launch phase when rapid changes are anticipated.

ID:
5874
6. The calibration shall also employ a technique involving measurements to address long-term stability for the solar reflective wavelengths.

ID:
5876
7.   The instrument vendor shall perform at least a pre-launch full-system radiometric calibration in all bands, filling the aperture and the entire optics/detector train as under the operational conditions.

ID:
5879
      8.   The vendor shall characterize the spectral response as a function of wavelength for each optical element in the optical train.

ID:
5880

9.   An independent laboratory approved by the government shall measure the spectral response of witness samples of the critical optical elements, namely the bandpass optical filters.

ID:
1788
Discussion: NOAA wants an onboard, reflected solar < 3 um calibration capability, but it must not introduce significant costs or risks through its approach or technology to the ABI's lifetime. A failure of the onboard calibration device shall not cause failure of the entire ABI mission. Complementary multiple techniques can be used to implement calibration. A NOAA workshop held on May 19, 1999 explored the availability of onboard ABI visible and near IR technologies and approaches. The results of the workshop are contained in JPL report "In Flight Visible and Near Infrared Calibration of Future GOES Imagers Workshop report," Dave Norris, October 1999, JPL report D-17846. The above onboard calibration requirements identified at the workshop were discussed as limits of what could be achieved. Ultimately, the lowest GPRD product accuracy of 5% is the driver. Thus the radiometric calibration will be tighter, at 3%. What NOAA wants is an onboard capability and some progress towards these limits.

ID:
1789
Discussion: Alternative Imager, on-board, reflected solar < 3 um calibration designs were discussed, such as

ID:
1790
  1. Stable on-board source of illumination;

ID:
1791
  2. The sun as a radiometric source via, e.g., reflection from diffuser plates or transmission through perforated plates.

ID:
1792
Standard diodes could be used with the preceding approaches to monitor the output of the on-board source, the reflectivity of the diffuser plate, or the transmittance of the perforated plate.

ID:
1793
        Benefits: Visible calibration, enabling accurate radiation measurements, will support such products as insolation at the surface, aerosol burden over the oceans, snow mapping, correction of sea surface temperatures from over the ocean derived aerosols, reducing the appearance of "seams" between image composites derived from different satellites.

ID:
5883
Discussion: Instrument intercomparison across platforms in all wavebands will be performed by NOAA, but nothing additional is mandated to the instrument vendor because of this plan.

ID:
1794

(2.10.1) 3.B.13. Emissive Infrared Calibration

ID:
1795
Full-system and full-aperture calibration shall be provided to achieve brightness temperature absolute accuracy of 1 degree Kelvin and relative precision of 0.2 degrees Kelvin for each band.

ID:
1796
            Discussion: Quantitative products derived from imager data for weather forecasting demand stable, calibrated data. Accurate knowledge of the system spectral response function (SRF), including both in-band and out-of-band response, is required for each band and the on-board black body is required. Relative precision includes line-to-line, detector-to-detector, and frame-to-frame repeatability of the measurement of the brightness temperature of a uniform scene.
 Signals from these bands shall be amplified and quantized in such a way that the signal will not saturate (high counts or low counts) over the life of the instrument and under worst-case conditions.

ID:
1797
Radiometric accuracy of the ABI system should be independent of scan position (or location of the target in the field of regard).
Discussion: Mirror emissivity measurements are typically measured by looking at space, and thus the field of regard of the aperture must be sized accordingly.

ID:
5875
        Radiance measurements in the reflected solar wavelength range shall be traceable to NIST standards. Traceability is defined as the property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties. (International Vocabulary of Basic and General Terms in Metrology, 1993; used by NIST. The Government assesses the vendors demonstrations of radiance traceability to NIST, which the vendor establishes through both 1) a measurement assurance program (an example of which is the purchasing of NIST sources (e.g., lamps, blackbodies) with adherence to specified recalibration schedules pre-launch), and 2) use of NIST best practices in radiance determinations, including quality programs detailing measurement procedures and reproducibility and using trained personnel.

ID:
1798
            Benefits: All IR images and products rely on accurate calibration.

ID:
5877
The instrument vendor shall perform a pre-launch full-system radiometric calibration in all bands, filling the aperture and the entire optics/detector train as under the operational conditions.

ID:
5881
An independent laboratory approved by the government shall measure the spectral response of witness samples of the critical optical elements, namely the bandpass optical filters.

ID:
5878
The vendor shall characterize the spectral response as a function of wavelength for each optical element in the optical train.

ID:
5882
Discussion: Instrument intercomparison across platforms will be performed by NOAA, but nothing additional is mandated to the instrument vendor because of this plan.

ID:
1799

(2.10.1) 3.B.14.   Low-light Imager

ID:
1800
There is a need for low-light dawn/dusk visible band imaging capability; not only for meteorological products, but also as an aid to improve navigation via star mapping and landmarks. The ABI shall include a low light level (5% albedo) visible (0.64 microns) imaging capability at 50:1 SNR with performance equivalent to the 0.64 microns visible channel.

ID:
1801
For the low light visible, no performance level shall be required during any eclipse period when the any point on the earth is within 10 degrees of the sun.

ID:
1802
Discussion: Star mapping, if chosen for navigation, may permit four (4) stars to be observed at least 95% of the time and 1 star at all times. The feasibility of introducing low light capability to the ABI is analyzed in JPL report JPL D-18485, JPL contract Task Plan 80-4867, Task 15 "Potential Low

Light Level Visible Imaging Capability for the Advanced Baseline Imager for GOES", February 2000, Hal Sobel. Further study of the low light capability has been conducted during formulation phase studies.

ID:
1803
Benefits: One-half kilometer resolution, low-light visible imagery would allow forecasters to discern fog and important thunderstorm outflow boundaries earlier in the morning, as well as later into the evening hours, during severe and tornadic storm events.

ID:
1804

(2.10.1) 3.B.15 Autonomous Override

ID:
1805
Ground commands shall inhibit any autonomous function upon command.

ID:
1806

(2.10.1) 3.C.Requirements derived from Engineering Studies

ID:
1807
In conducting concept studies and technology and risk trade analyses, NOAA has determined several preferred instrument characteristics that are described here as design or engineering requirements:

ID:
1808

(2.10.1) 3.C.1.   Ground processing needs

ID:
1809
Where the imager design requires that ground processing of image data be done in order to meet certain data specifications (e.g., co-registration, MTF matching across IR bands, navigation accuracies), then such processing shall be included in the overall imager system design."

ID:
1810
Discussion: NOAA recognizes that some optical designs may be simplified or allow for delivery of better quality data meeting defined image quality specifications if certain aspects of data processing are performed with ground equipment. Any ground processing aspects of the "imager system" must still allow the stated timeliness requirements to be met.

ID:
1811
Discussion: There are several requirements that can be aided by ground processing and adequately sampled imagery. It is possible, with sufficient information, to resample the IR imagery to correct for navigation, registration and co-registration errors. Matching of system MTF across IR bands is possible with digital filters in ground processing. Instead of detector geometry dominating the spatial response to achieve band independent resolution, any detector and aperture size combination that satisfies the system MTF requirement can be normalized across bands on the ground. Nighttime IR land marking is more accurate with the current required resolution, aiding the challenging INR requirements. The enhanced land marking ability also enables better determination of non-static co-registration errors.

ID:
1812
Algorithms and hardware capable of verifying all instrument parameters at the output of any ground-processing running at rates comparable with scanning rates will be developed. This is to ensure any proposed processing is achievable within the limits described in this section.

ID:
1813

(2.10.1) 3.C 2.   Removed requirement

ID:
1814

(2.10.1) 3.C.3.   Limits to Downlink Data Rates

ID:
1815
    NOAA assumes that the GOES spacecraft communications system will serve to relay ABI data to NOAA ground receive systems in real time and not store-and-forward it. Currently, the ABI data rate is 60 Megabits per second (Mbps).

ID:
1816
    Discussion: The results of ABI formulation studies has indicated that an ABI data rate of 60 Megabits per second (Mbps) is reasonable and reflects NOAA's current plan to increase data rates through the use an of X-band for the sensor data downlink. This data rate is a combination of lossy compression of some of the reflected solar bands and lossless compression the emissive IR bands, detailed in the section below. The X-band frequency requests are detailed in an appendix to this document.

ID:
1817

ID:
1818

(2.10.1) 3.C.4.   Data compression acceptability

ID:
1819

NOAA recognizes that in order to meet both timeliness requirements on the products and downlink data bandwidth limitations, some form of image data compression may need to be invoked. The following summarizes acceptability of lossless and lossy compression.

ID:
1820

Compression of the 1.38 um band and of the all the band with wavelengths > 2 um shall be carried out by any means (e.g., Huffman coding, arithmetic coding, Rice algorithm) which permit lossless reconstruction of the data.

ID:
1821

Compression of visible (0.64 um), 0.47 um, 0.86 um, and the 1.61 um bands data shall meet the requirements outlined in Table 4.
Discussion: The peak SNR requirement ensures that the signal-to-noise ratio of the original image is preserved. The correlated noise metric measures the amount of correlated noise, or "blocking artifacts", that is often present in compressed images. This type of distortion typically occurs with compression algorithms that independently code sub-images or blocks of the original image, and is known to be very apparent to the human eye. The referenced metric computes a weighted average of vertical and horizontal edges present in the image where the weights are determined by the surrounding neighborhood contrast. The requirement allows for a 10% increase in distortion. This level was found to be consistent with subjective evaluations of image quality.

ID:
1822

In addition to the requirements in Table 4, the spatial frequency content of the original image shall be maintained so that the system MTF requirement (see above) is met after compression.
Discussion: Experience with the Joint Photographic Experts Group (JPEG) compression algorithm and visible imagery has shown that the stated requirements can be met using at least a 3:1 compression ratio.

ID:
1823

Table 4. Visible (0.64 um), 0.47 um, 0.86 um and 1.61 um Data Compression Requirements

Metric	Definition	Requirement
Peak SNR	See first equation below for PSNR	PSNR >= 50dB

	where MxN is the image size, Nmax is the maximum scene radiance described in Table 3 above, Xij refers to the original imager and Xij refers to the reconstructed image.	
Correlated noise	M=0.5*(MhGBIM +MvGBIM), where MhGBIM and MvGBIM are defined in [1]	See second equation below where M_{RC} is the metric for the reconstructed image, and M_{ORIG} is for the original image

ID:
6335
<Picture>

$$PSNR = 20 \log_{10}\left(\frac{N_{max}}{\sqrt{\frac{1}{MN}\sum_{i=1}^{N}\sum_{j=1}^{M}(X_{i,j} - \overline{X}_{i,j})^2}} \right)$$

ID:
6336
<Picture>

$$\frac{M_{RC}}{M_{ORIG}} < 1.1$$

ID:
1837
[1] H.R. Wu, "A New Distortion Measure for Video Coding Blocking Artifacts," in Proceedings of the 1996 International Conference on Communication Technology, vol. 2, May 5-7, 1996, Beijing, China, pp. 658-661.

ID:
1838
The ABI shall be capable of switching between lossy and lossless on orbit, upon command, although the 60 Mbps data rate will not apply if the data compression is commanded off.

ID:
1839
Commanded switching from lossy to lossless shall be on a band-by-band basis.

ID:
1840

(2.10.1) 3.C.5. Space Environment

ID:
1841

      The instrument shall be designed to withstand electrostatic charging and radiation effects which may be expected in a geosynchronous orbital environment between 75 degrees West and 135 degrees West.

ID:
1842

(2.10.1) 3.C 6. Stray Magnetic Fields

ID:
1843

The change in the magnetic field of the instrument module associated with any instrument operation shall be less than 20 nT, peak to peak, in any axis when measured at a distance of 1 meter from any face of the scan mechanism. The change in the magnetic field of any other instrument module (e.g. power supply or electronics) associated with any instrument operation shall be less than 10 nT, peak to peak, in any axis when measured at a distance of 1 meter from any face of that module.
Discussion: Note that the total change for the entirety of ABI will be less than 30 nT. This need is driven by the magnetometer.

ID:
1844

(2.10.1) 3.C.7. Linearity

ID:
1845

      The linearity of the IR bands, before calibration, shall be measured prior to launch, and must be within ± 1%. There is no linearity requirement above the 375 range for the 3.9 um band.

ID:
1846

(2.10.1) 3.C 8. Spacecraft Interface Design Goals:

ID:
1847

a) <u>Cooling:</u> The IR detectors shall be passively cooled or actively cooled.

ID:
1848
b) Operational Conditions: It is anticipated there may be a spring and fall yaw flip. After such a flip (considered a maneuver), the instrument shall be able to meet all of its requirements within 1 hour.

ID:
1849

(2.10.1) 3.C.9. Future Growth

ID:
1850
Design features, which support modular improvements are advantageous.

ID:
1851

(2.10.1) 3.C.10. Operability

ID:
1852
ABI shall have 100% pixel operability.

ID:
1853

(2.10.1) 3.C.11. Polarization Control Requirement

ID:
1854
ABI channels with wavelengths <2 microns shall have less than 4% sensitivity to the polarization of incoming light. The difference in sensitivity to polarization between channels shall be less than 2%. The uncertainty in the sensitivity to polarization within a channel shall be less than 1% (TBR). The polarization insensitivity requirements shall be met at all Earth-viewing angles throughout the life of the mission, and, as a goal, the insensitivity requirements should be met over the entire field-of-regard.
Discussion: Halving the sensitivity to the polarization of incoming light and the uncertainty in the sensitivity to polarization would provide a benefit to NOAA.

ID:
1855
Polarization sensitivity is defined as the ratio of the difference between maximum and minimum output to the sum of the maximum and minimum output obtained when the plane of incoming 100% linearly polarized radiation is rotated through 180 degrees.

ID:
1856

(2.10.1) 3.C.12. Removed

ID:
1857

2.10.2 HES

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(2.10.2) 1.   HES Requirements Description and Overview

ID:
1938
The Hyperspectral Environmental Suite (HES) is located on a geostationary platform, specifically either the B satellites of the distributed architecture or both of the consolidated satellites described in section 2.3 of the MRD, and comprises one or multiple instruments procured under one contract. HES contains threshold and goal tasks. The threshold jobs that are assigned to the HES are Disk Sounding (DS) for temperature and moisture, severe weather/mesoscale (SW/M) sounding for temperature and moisture at improved spatial resolution, and coastal waters (CW) observations at improved spatial resolution. The goal job is the parallel task of open ocean (OO) observations, at coarser spatial resolution compared to the CW task observations Each of these tasks is described in more detail below. These threshold and goal tasks may be met with one instrument, several instruments, or multiple instruments. If all tasks are met, the HES may also provide a degraded ABI backup capability.

ID:
1939
When all tasks are met, HES will provide measurements of the traditional temperature and water vapor vertical profiles as well as measurements of the properties of the earth's surface, in particular oceans. These additional capabilities will meet the needs of NOAA in ocean areas that have not been well covered by the current imager or sounder due to lack of spectral coverage in the reflected solar spectrum, as well as high resolution spatial coverage in the coastal water. In particular, the region where most of the anomalous ocean conditions occur is the category of the estuaries, lakes, coastal waters, with water depths of less than 500 meters within about 20 km from the shore, and shelf waters, with water depths of less than about 2 km within 400 km from the shore. The open ocean, by contrast, has depths of greater than about 2 km. The ~400 km range from the shore is comprise of the ~12 nautical miles (22.22 km) of the territorial sea originating at the low tide water line and the additional 200 nautical mile width (370.4 km) from the outer edge of the territorial sea to the Exclusive Economic Zone (EEZ).

ID:
1940

(2.10.2) 2. Background Information and Design Goals for the HES

ID:
1941
NOAA expects that available technology should be used to design a Hyperspectral Environmental Suite that at a minimum meets this document's threshold requirements. Modularity in design should be considered where it permits introduction of improvements in successive units (i.e. GOES T or U) that may not be sufficiently mature to be included in beginning of the GOES-R series. Similarly, goal requirements that are not met initially by GOES-R may be implementable over a period either through

pre-planned product improvement (P^3I) or though modularity. Critical performance parameters for the DS task of the HES are the scanning rates (i.e. spatial coverage), NEdN, and detector-optics ensquared energy. Critical performance parameters for the SW/M task of the HES are the spatial resolution and the coverage rate. Critical performance parameters for the CW task of the HES are the spatial resolution and the spectral coverage. Critical performance parameters for the OO task of the HES are the spectral coverage.

ID:
1942
In conducting concept studies and technology and risk trade analyses, NOAA has determined several preferred instrument characteristics that are described here as design or engineering requirements:

ID:
1943

(2.10.2) 2.A. Instrument Description Assumptions

ID:
1944

ID:
1945
NOAA's NWS has a need for improved vertical resolution, compared to the GOES I-M series or GOES-N-Q series sounders, for improved weather forecasting. Employing the improved spectral resolution along the CO_2, H_2O, and O_3 absorption features can deliver that improved vertical resolution. The sounding instrument or instruments will measure scene radiances that can be converted into vertical soundings of temperature and humidity through a numerical procedure (known as retrieval analysis) that is implemented (through ground processing) as part of the HES system.

ID:
1946
In order to produce the desired improved spectral resolution for the DS and SW/M tasks, energy from the earth's atmosphere will either be interfered or dispersed. An instrument employing interference for that desired spectral resolution is called an interferometric spectrometer here. An instrument employing dispersion for that desired spectral resolution is called a dispersive spectrometer. An instrument utilizing a combination of these two methods is not excluded; as more tasks are included, the method by which the desired resolution is achieved may vary with wavelength. *Any types of instruments will include resolutions and coverage of spectral regions that are either generally consistent with those described in this document or are shown to provide the same performance by either satellite or aircraft flight-testing data. See section 3.B.2.g. for further comments on wavebands.*

ID:
1947
It is anticipated that the OO task and the CW task will be met by one of three general classes of instruments: a multiple band radiometer where the number of bands is nominally less than 10, multiple

band radiometer where the number of bands is nominally greater than 10, or a dispersive spectrometer yielding higher resolution at all wavelengths in the range producing more than 100 channels. Again, combination of these types is not excluded.

ID:
1948

(2.10.2) 2.B.   Spacecraft Interface Design Considerations

ID:
1949
During the initial concept studies, two point designs were generated for NOAA/NESDIS by MIT Lincoln Laboratory in order to address the feasibility of requirements to perform only the DS task of the HES system. These instrument designs have volumes of approximately 1 cubic meter, apertures of no less than 30 cm, data rate of about 12 Mbps, and power consumption of ~200 W. For those studies, the mass, volume, and power consumption were assumed to be the same as on the GOES N-P bus. However, it is anticipated that the HES may be larger with higher power consumption and larger data rates in order to perform more tasks of the HES by adding any multichannel or hyperspectral capability in the reflected solar region. HES instruments need to be compatible with the satellite in any architecture discussed in section "Constellation Description". NOAA encourages innovative design and recognizes certain proposed instruments may offer tradeoffs between performance, cost-effectiveness, and these physical interface parameters. Such trades may result in different bus parameters.

ID:
1950

(2.10.2) 3.   Performance Characteristics

ID:
1951
Requirements listed in this section for the atmosphere derive from the GOES Program Requirements Document-1 (GPRD-1), July 2004, which updates both the NOAA's Geosynchronous Operations Requirements Document-I (GORD-I) and the NOAA's NWS Operation Requirements Document (ORD) and frames the rationale primarily for the HES DS task performance characteristics and less formally the SW/M task performance characteristics. The requirements for the CW task as well as the OO task are derived from the GPRD-1. The bands in these tasks come from typical algorithms used for either geosynchronous and/or polar satellites. Additional requirements that are derived from technical concept studies and trade analyses are subsequently listed in other portions of this document.

ID:
1952
This document employs a two-level definition for most of the requirements:

ID:
1953

THRESHOLD: The minimum acceptable capability at end-of-life required at the beginning of the proposed series of satellites. All requirements are threshold unless noted as goals.

ID:
1954
GOAL: This is an enhanced capability level beyond the THRESHOLD level of performance needed to support future NOAA and other user operations and environmental needs. This level of performance should be achieved when technically and financially feasible, as determined by NOAA, during the series of satellites by continually infusing advances in technology that improve services with minimal effect on total project costs.

ID:
1955
Future Enhancements: Design features that would support modular improvement in moving from any of the THRESHOLDS towards GOALS would be advantageous.

ID:
1956
The threshold requirements specified here in the MRD-2B are generally consistent with those from the GPRD-1. The goal requirements from the MRD-2B (called the objective requirements in the GPRD-1) may differ from those in the GPRD-1, reflecting acknowledged technical, scientific, cost or development time factors determined during the initial concept studies for the instruments other than the ABI.

ID:
1957
Thus, the DS task is a THRESHOLD task. The SW/M task is a THRESHOLD task. The OO task is a GOAL task. The CW task is a THRESHOLD task. Within each THRESHOLD task, there are THRESHOLD and GOAL requirements. Within each GOAL task, there are THRESHOLD and GOAL requirements.

ID:
1958
The DS task will meet the following observational requirements detailed in the GPRD-1. It is critical to note that this information is included here is for reference only and provides traceability to the GPRD-1. The detailed requirements for the HES are detailed in subsections *after* this section. (See section 2.11.3 for relevant comments.) All parameters listed here are threshold values and may be exceeded to meet goal values. All parameters listed here are threshold values and may be exceeded to meet goal values. Goal values are currently listed in Appendix A.

ID:
1959
For reference, the distinction between "measure" and "Contribute to determinations of" indicates whether the GPRD-1 requirement is being fully met by a direct measurement performed by the instruments ("measure") or is being determined indirectly from measurements supplied in part or in whole by the instruments ("Contribute to determinations of").

ID:
1960
The DS task will ***contribute*** to the **Dust / Aerosol: Loading-CONUS** determinations. The DS task provides total vertical column coverage over the CONUS to assist ABI in addressing the following details of the threshold requirement for the **Dust / Aerosol: Loading--CONUS**: over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values integrated over the total column; contributing 5 km threshold mapping uncertainty (baseline); over the range of Light, Moderate, Heavy; and with TBD accuracy.

ID:
1961
The DS task will ***contribute*** to the **Dust / Aerosol: Loading-"Hemispheric"** determination to address the following details of the threshold requirement for the **Dust / Aerosol: Loading-"Hemispheric"**: over the 62 degree LZA disk; with a threshold 60 minute refresh; with TBD threshold data latency; at 10 km threshold resolution by using the radiance values integrated over the total column; using 5 km threshold mapping uncertainty; over the range of Light, Moderate, Heavy; and with TBD accuracy.

ID:
1962
The DS task will ***contribute*** to the **Aircraft Icing Threat** determination to address the following details of the threshold requirement for the **Aircraft Icing Threat**: over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 15 minute threshold latency; at 10 km threshold resolution, with 1 km top height resolution; using 5 km threshold mapping uncertainty; over the range of None - Heavy; and with 2 category accuracy.

ID:
1963
The DS task will ***contribute*** to **the Cloud Base Height: CONUS** determination to attempt to address the following details of the threshold requirement for the **Cloud Base Height: CONUS** over the 3000 km x 5000 km CONUS; contributing a threshold 60 minute refresh (baseline); with a 1 minute threshold latency; 10 km threshold resolution by using temperature and moisture profiles with 2 km vertical resolution; using 5 km threshold mapping uncertainty; over the range of 0-(TBS) km; and with 2.0 km cloud base accuracy.

ID:
1964
The DS task will ***contribute*** to **the Cloud Base Height: "Hemispheric"** determination to attempt to address the following details of the threshold requirement for the **Cloud Base Height: "Hemispheric"** over the 62 degree LZA disk; contributing a threshold 60 minute refresh (baseline); with a 1 minute threshold latency; contributing a 10 km threshold resolution by using temperature and moisture profiles with 2 km vertical resolution; using 5 km threshold mapping uncertainty; over the range of 0-(TBS) km; and with 2.0 km cloud base accuracy.

ID:

1965

The DS task will *contribute* to the **Cloud Layers/ Heights and Thickness: CONUS** determination along with ABI to attempt to address the following details of the threshold requirement for the **Cloud Layers/ Heights and Thickness: CONUS** over the 3000 km x 5000 km CONUS; contributing a threshold 60 minute refresh (baseline); with a 15 minute threshold latency; at 10 km threshold resolution by using the radiance values; with TBS vertical resolution; using 5 km threshold mapping uncertainty; over the measurement range of heights of 0-5 layers and thickness by general cloud type; and with TBS accuracy on thickness and height.

ID:
1966

The DS task will *contribute* to the **Cloud Layers/ Heights and Thickness: Hemispheric** determination along with ABI. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details of the threshold requirement for the **Cloud Layers/ Heights and Thickness: Hemispheric** over the 62 degree LZA disk; with a threshold 60 minute refresh; with TBD threshold data latency; at 10 km threshold resolution by using the radiance values; with TBD vertical resolution; using 5 km threshold mapping uncertainty; over the measurement range of heights of 0-5 layers and thickness by general cloud type, and with TBD accuracy on thickness and height.

ID:
1967

The DS task will *contribute* to the **Cloud Particle Size Distribution: CONUS** determined indirectly by ABI by contributing background temperature and moisture fields. The following details the threshold requirements for **Cloud Particle Size Distribution: CONUS**: over the 3000 km x 5000 km CONUS; with a threshold 5 minute refresh; 1 minute data latency; 2 km spatial resolution, with Cloud Top vertical resolution; over the range of 0 - 50 µm, with an accuracy of 4 µm; and 1.0 km mapping accuracy.

ID:
1968

The DS task will *contribute* to the **Cloud Particle Size Distribution: Hemispheric** determined indirectly by ABI by contributing background temperature and moisture fields. The following details the threshold requirements for **Cloud Particle Size Distribution: Hemispheric**: over the full disk; with a threshold 15 minute refresh; 1 minute data latency; 2 km spatial resolution, with Cloud Top vertical resolution; over the range of 0 - 50 µm, with an accuracy of 4 µm; and 1.0 km mapping accuracy.

ID:
1970

The DS task will *contribute* to the **Cloud Top Height: CONUS** determination along with ABI contributions. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Cloud Top Height: CONUS** over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; with vertical resolution of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km; over then range of

heights of 100m - 300 hPa; with measurement accuracy of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km.

ID:
1971
The DS task will ***contribute*** to the **Cloud Top Height: Hemispheric** determination along with ABI. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details of the threshold requirement for the **Cloud Top Height: Hemispheric** over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; with vertical resolution of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km; using 5 km threshold mapping uncertainty; over then range of heights of 0-15 km; with measurement accuracy of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km.

ID:
1972
The DS task will ***contribute*** to the **Cloud Top Pressure: CONUS** determination along with ABI to address the following details of the threshold requirement for the **Cloud Top Pressure: CONUS** over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 10 minute threshold latency; at 10 km threshold resolution by using the radiance values; with vertical resolution of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km; using 5 km threshold mapping uncertainty; over then range of heights of 100m - 300 hPa; with measurement accuracy of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km.

ID:
1973
The DS task will ***contribute*** to the **Cloud Top Pressure: Hemispheric** determination with contributions from ABI. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details of the threshold requirement for the **Cloud Top Pressure: Hemispheric** over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; with vertical resolution of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km; using 5 km threshold mapping uncertainty; over then range of heights of TBD; with measurement accuracy of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km.

ID:
1974
The DS task will ***contribute*** to the **Cloud Top Temperature: Hemispheric** determined by ABI by contributing background temperature and moisture fields. These background fields are collected over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty. The following details the threshold requirements for **Cloud Top Temperature: Hemispheric:** over the full disk; with a threshold 15 minute refresh; 1 minute data latency; 2 km spatial resolution, with at Cloud Top vertical resolution; over the range of 180-300 K, with an accuracy of 1 K; and 1.0 km mapping accuracy.

ID:
1975
The DS task will ***contribute*** to the **Cloud Type: CONUS** determined by ABI by contributing background temperature and moisture fields. These background fields are collected over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty. The following details the threshold requirements for **Cloud Type: CONUS:** over the 3000 km x 5000 km CONUS; with a threshold 30 minute refresh; 10 minute data latency; 10 km spatial resolution, with at TBD vertical resolution; over the range of 7 types, with an accuracy of TBD; and 5.0 km mapping accuracy.

ID:
1976
The DS task will ***contribute*** to the **Cloud Type: Hemispheric** determined by ABI by contributing background temperature and moisture fields. These background fields are collected over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty. The following details the threshold requirements for **Cloud Type: Hemispheric**: over the fill disk, with 15 min refresh rate; 1 min data latency; 2 km spatial resolution, with TBD vertical resolution, over the range of 7 types, with an accuracy of TBD, and 1 km mapping accuracy.

ID:
1977
The DS task will ***contribute*** to the **Turbulence: Hemispheric** determined by ABI by contributing background temperature and moisture fields. These background fields are collected over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty. The following details the threshold requirements for **Turbulence: Hemispheric**: over the fill disk, with 15 min refresh rate; 1 min data latency; 2 km spatial resolution, with Sfc-500 mb: 300-500 m, 500-300 mb: 1-2 km, 300-100 mb: 1-2 km, 100 mb and above: 2-3 km vertical resolution, over the range of binary (moderate or greater (over 100 m - 4 km), with an accuracy of TBD; and 1 km mapping accuracy.

ID:
1978
The DS task will ***contribute*** to the **Rainfall Potential** determination of ABI (and of the P³I Microwave called GMS) by contributing background temperature and moisture fields. These background fields are collected over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty. The following details the threshold requirements for **Rainfall Potential:** over the fill disk, with 15 min refresh rate; 5 min data latency; 2 km spatial resolution; with TBD vertical resolution, over the range of 0-100 mm/hr, with an accuracy of 5 mm/hr; and 1 km mapping accuracy.

ID:
1979
The DS task will *measure* the **Atmospheric Vertical Moisture Profile: CONUS** to address the following details of the threshold requirement for the **Atmospheric Vertical Moisture Profile: CONUS** over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution by using the radiance values; with vertical sampling from the surface to 500 mbar of 300 m to 500 m, from 500 to 300 mbar sampling 1-2 km, from 300 to 100 mbar sampling 1-2 km; using 5 km threshold mapping uncertainty; a measurement range of 0 - 100%, with 10% measurement accuracy from the surface to 500 mbar with 300 m to 500 m vertical sampling, 10% from 500 to 300 mbar with 1-2 km vertical sampling, and 20% from 300 to 100 mbar with 1-2 km vertical sampling. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute.

ID:
1980
The DS task will *measure* the **Atmospheric Vertical Moisture Profile: Hemispheric** to address the following details of the threshold requirement for the **Atmospheric Vertical Moisture Profile: Hemispheric** over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution by using the radiance values; with vertical sampling from the surface to 500 mbar of 300 m to 500 m, from 500 to 300 mbar sampling 1-2 km, from 300 to 100 mbar sampling 1-2 km; using 5 km threshold mapping uncertainty; a measurement range from 0-100%, with 10% measurement accuracy from the surface to 500 mbar with 300m to 500m vertical sampling, 10% from 500 to 300 mbar with 1-2 km vertical sampling, and 20% from 300 to 100 mbar with 1-2 km vertical sampling. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
1981
The DS task will *measure* the **Atmospheric Vertical Temperature Profile: CONUS** to address the following details of the threshold requirement for the **Atmospheric Vertical Temperature Profile: CONUS** over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution by using the radiance values; with vertical sampling from the surface to 500 mbar of 300 m to 500 m, from 500 to 300 mbar sampling 1-2 km, from 300 to 100 mbar sampling 1-2 km, from 100 mbar and up with 2-3 km vertical sampling; with a measurement range of 180 - 330 K, using 5 km threshold mapping uncertainty; over the range of 180 to 330 K employing the following layering and precision: 0.3 to 0.5 km vertical sampling from the surface to 500 mbar, +/- 1 K from 500 to 300 mbar with 1-2 km vertical sampling, +/- 1K from 300 to 100 mbar with 1-2 km vertical sampling; and +/- 1K from 100 mbar and up with 2-3 km vertical sampling. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute.

ID:
1982
The DS task will *measure* the **Atmospheric Vertical Temperature Profile: Hemispheric** to address the following details of the threshold requirement for the **Atmospheric Vertical Temperature Profile:**

Hemispheric over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; over the range of 180 to 330 K employing the following layering and precision: 0.3 to 0.5 km vertical sampling from the surface to 500 mbar, +/- 1 K from 500 to 300 mbar with 1-2 km vertical sampling, +/- 1K from 300 to 100 mbar with 1-2 km vertical sampling; and +/- 1K from 100 mbar and up with 2-3 km vertical sampling. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
1983
The DS task will *measure* the **Capping Inversion Information: CONUS.** The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Capping Inversion Information: CONUS** over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 4 km threshold mapping uncertainty; over the range of 210 to 300 K for both T and Td and heights of surface to 650 mbar, with accuracies of 10 K accuracy for T and Td and 150-250 mbar for height. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute.

ID:
1984
The DS task will *contribute* to the **Derived Stability Indices: CONUS** determination of ABI by contributing background temperature and moisture fields. These background fields are collected over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty. The following details the threshold requirements for **Derived Stability Indices: CONUS**: over the 3000 km x 5000 km CONUS, with 30 min refresh rate; 3 min data latency; 4 km spatial resolution, with TBD vertical resolution, over the range of TBD, with an accuracy of TBD; and 1 km mapping accuracy.

ID:
1985
The DS task will *contribute* to the **Moisture Flux: CONUS** of HES and ABI. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Moisture Flux: CONUS** over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution, by using the radiance values; vertical sampling of 0.3 to 0.5 km from the surface to 500 mbar, 1-2 km vertical sampling from 500 to 300 mbar, 1-2 km vertical sampling from 300 to 100 mbar; using 5 km threshold mapping uncertainty; over the range of 0-20 g/kg/h; and with 10% accuracy. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute.

ID:
1986

The DS task will *contribute* to the **Moisture Flux: Hemispheric** of HES and ABI. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Moisture Flux: Hemispheric**: over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution, by using the radiance values; vertical sampling of 0.3 to 0.5 km from the surface to 500 mbar, 1-2 km vertical sampling from 500 to 300 mbar, 1-2 km vertical sampling from 300 to 100 mbar; using 5 km threshold mapping uncertainty; over the range of 0-20 g/kg/h; and with 10% accuracy. This measurement is <u>required only in clear and above cloud regions for this instrument</u>. A microwave instrument, if present, would also contribute.

ID:
1987

The DS task will ***contribute to*** the **Total Precipitable Water: Hemispheric.** The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details of the threshold requirement for the **Total Precipitable Water: Hemispheric** over the 62 degree LZA disk; with a threshold 60 minute refresh; with a TBD minute threshold latency; at 100 km threshold resolution, by using the radiance values; using TBD threshold mapping uncertainty over the range of TBD; and with TBD accuracy. This measurement is <u>required only in clear and above cloud regions for this instrument</u>. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
1988

The DS task will *measure* the **Total Water Content: CONUS.** The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Total Water Content: CONUS** over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution, by using the radiance values; using 5 km threshold mapping uncertainty; over the total vertical column; over the range of 0-100 mm; and with TBD accuracy. This measurement is <u>required only in clear and above cloud regions for this instrument</u>. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
1989

The DS task will *measure* the **Total Water Content: Hemispheric**. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution; using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Total Water Content: Hemispheric** over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; over the range of 0-100 mm; and with TBD accuracy. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
1990

The DS task will *contribute to* the **Clear Sky Masks: CONUS** determinations for the DS task using the temperature from the HES-DS task and the visible channel. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details of the threshold requirement for the **Clear Sky Masks: CONUS**: over the 3000 km x 5000 km CONUS; with a threshold 15 minute refresh; with a 15 minute threshold latency; at 2 km threshold resolution; using 1 km threshold mapping uncertainty; over the range of 0-1binary; and with a 10% accuracy.

ID:
1991
The DS task will *contribute to* the **Clear Sky Masks: Hemispheric** determinations for the DS task using the temperature from the HES-DS task and the visible channel. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details of the threshold requirement for the **Clear Sky Masks: Hemispheric**: over the62 degree LZA disk; with a threshold 15 minute refresh; with a 15 minute threshold latency; at 2 km threshold resolution; using 1 km threshold mapping uncertainty; over the range of 0-1binary; and with a 10% accuracy.

ID:
1992
The DS task will *measure* the **Radiance: CONUS.** The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Radiance: CONUS** over the 3000 km x 5000 km; with a threshold 60 minute refresh; with a 10 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; with vertical sampling and layering of 300-500 m from the surface -500 mb, 1-2 km from 500-300 mb, 1-2 km from 300-100 mb, and 2-3 km from 100 mb and up; over the range of 180-330 K (for visible and IR only); and with TBD accuracy. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
1993
The DS task will *measure* the **Radiance: Hemispheric**. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Radiance: Hemispheric** over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 60 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; with vertical sampling and layering of 300-500 m from the surface -500 mb, 1-2 km from 500-300 mb, 1-2 km from 300-100 mb, and 2-3 km from 100 mb and up; over the range of 180-330 K (for visible and IR only); and with TBD accuracy. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
1994
The DS task will ***contribute to*** a determination of the **Upward Longwave Radiation: Surface/ CONUS.** The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Upward Longwave Radiation: Surface/ CONUS**: over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 60 minute threshold latency; at 25 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; with n/a vertical sampling; over the range of 0-700 W/m^2; and with (TBS) accuracy.

ID:
5837
The DS task will ***contribute to*** a determination of the **Upward Longwave Radiation: Surface/ Hemispheric.** The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Upward Longwave Radiation: Surface/ Hemispheric**: over the 62 degree LZA; with a threshold 60 minute refresh; with TBD threshold data latency; at 100 km threshold resolution by using the radiance values; using TBD km threshold mapping uncertainty; with n/a vertical sampling; over the range of TBD W/m^2; and with TBD accuracy.

ID:
1995
The DS task will ***contribute to*** a determination of the **Upward Longwave Radiation: TOA/ CONUS**. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Upward Longwave Radiation: TOA/ CONUS**: over the 3000 km x 5000 km; with a threshold 60 minute refresh; with a 60 minute threshold latency; at 25 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; with n/a vertical sampling; over the range of 0-700 W/m^2; and with 20 W/m^2 accuracy.

ID:
1996
The DS task will ***contribute to*** a determination of the **Upward Longwave Radiation: TOA/ Hemispheric**. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Upward Longwave Radiation: TOA/ Hemispheric**: over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 60 minute threshold latency; at 25 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; with n/a vertical sampling; over the range of 0-700 W/m^2; and with 20 W/m^2 measurement accuracy.

ID:

1997

The DS task will ***measure* CO Concentration**. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **CO Concentration**: over the 62 degree LZA disk; with a threshold TBD minute refresh; with a TBD minute threshold latency; at TBD threshold resolution by using the radiance values; using TBD threshold mapping uncertainty; over the range of TBD; and with TBD accuracy.

ID:
1999
Removed

ID:
2000
     Removed

ID:
6581
     The DS task will ***measure* Ozone Total: CONUS**. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Ozone Total: CONUS**: over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 60 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; with TBD vertical sampling; over the range of 50 - 650 Dobson units; and with 6% measurement accuracy.

ID:
6582
     The DS task will ***measure* Ozone Total: Hemispheric**. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Ozone Total: Hemispheric**: over the full disk; with a threshold 60 minute refresh; with a 5 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; with TBD vertical sampling; over the range of 100 - 650 Dobson units; and with TBD measurement accuracy.

ID:
2001

The DS task will ***contribute*** to the **Derived Motion Winds: CONUS** of ABI to supply background temperature and moisture fields. These background fields are collected over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty. The following details the threshold requirements for **Derived Motion Winds: CONUS**: over the 3000 km x 5000 km CONUS; with a threshold 5 minute refresh; with a 3 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; with 4 level vertical resolution

(Low, Mid, Mid-High, High); over the range of 0 - 300 knots (0 - 155 m/sec); and with an accuracy of Low level: 2.5 m/s, Mid level 4 m/s, High level: 6 m/s.

ID:
2002
The DS task will ***contribute*** to the **Derived Motion Winds--Hemispheric** of ABI to supply background temperature and moisture fields. These background fields are collected over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty. The following details the threshold requirements for **Derived Motion Winds--Hemispheric**: over the full disk; with a threshold 5 minute refresh; with a 3 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; with 4 level vertical resolution (Low, Mid, Mid-High, High); over the range of 0 - 300 knots (0 - 155 m/sec); and with an accuracy of Low level: 2.5 m/s, Mid level 4 m/s, High level: 6 m/s.

ID:
6362
        The DS task will *contribute to* the determinations of **Microburst Windspeed Potential** of ABI in the atmosphere for CONUS. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Microburst Windspeed Potential**: over the 3000 km x 5000 km CONUS; at 10 km spatial resolution, 60 minute refresh rate, 5 km mapping accuracy, and 3 minute threshold latency; with TBD vertical resolution, TBD measurement range, and TBD accuracy.

ID:
2003
The DS task will ***contribute*** to the **Flood Standing Water--Hemisphere** of ABI by supplying surface emissivity. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Flood Standing Water--Hemisphere** over the full disk; at 10 km spatial resolution, 60 minute refresh rate, 5 km mapping accuracy, and 6 hour threshold latency; with 5 cm vertical resolution, with 0 - 100% measurement range, and n/a accuracy.

ID:
2004
        The DS task will ***contribute*** to the **Land Surface (Skin) Temperature: CONUS** of ABI and HES by supplying surface emissivity. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Land Surface (Skin) Temperature: CONUS**: over the 3000 km x 5000 km CONUS; at 2 km spatial resolution, 60 minute refresh rate, 5 km mapping accuracy, and 60 minute threshold latency; over 230 - 330 K measurement range, and 1 K accuracy.

ID:
2005
> The DS task will *contribute* to the **Land Surface (Skin) Temperature: Hemispheric** of ABI and HES by supplying surface emissivity. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirement for the **Land Surface (Skin) Temperature: Hemispheric**: over the full disk; at 10 km spatial resolution, 60 minute refresh rate, 5 km mapping accuracy, and 3 minute threshold latency; over 230 - 330 K measurement range, and 1 K accuracy.

ID:
2006
The DS task will *measure* the **Surface Emissivity**. The DS task collects over the 62 degree LZA disk; with a threshold 60 minute refresh; with a 3 minute threshold data latency; at 10 km threshold resolution (1.0 km for visible); using 5 km threshold mapping uncertainty. The following details the threshold requirements for the **Surface Emissivity**: over the 3000 km x 5000 km CONUS; with a threshold 60 minute refresh; with a 60 minute threshold latency; at 10 km threshold resolution by using the radiance values; using 5 km threshold mapping uncertainty; over the range of 0.85 - 1.0 (unitless); and with 0.05 accuracy.

ID:
2007
The SW/M task will meet the following observational requirements detailed in the GPRD-1. (See section 2.11.3 for relevant comments.) Goal values are currently listed in Appendix A.

ID:
2008
The SW/M task will *contribute to* **Volcanic Ash** in the atmosphere. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Volcanic Ash**: 2 km spatial resolution, 15 minute refresh rate, 2 km vertical resolution on top height, a measurement range of 0-50 metric tons/km^2 with an accuracy of 2 tons/km^2, 1.0 km mapping accuracy, and 1 minute data latency need.

ID:
2009
The SW/M task will *contribute* to **the Cloud Base Height: Mesoscale** determination to attempt to address the requirement. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Cloud Base Height: Mesoscale** over the 1000 km x 1000 km mesoscale; contributing a threshold 5 minute refresh (baseline); with a 1 minute threshold latency; contributing a 4 km threshold resolution by using temperature and moisture profiles with 2 km vertical resolution; using 2 km threshold mapping uncertainty; over the range of 0 - TBD km; and with 2.0 km cloud base accuracy.

ID:
2010
The SW/M task will *measure* the **Cloud Layers/ Heights and Thickness: CONUS** determination along with ABI. The SW/M task can provide coverage over the 5000 km x 3000 km; contributing a threshold 70 minute refresh; with a 15 minute threshold latency; contributing 4 km threshold resolution; contributing 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Cloud Layers/ Heights and Thickness: CONUS** over the 5000 km x 3000 km; contributing a threshold 60 minute refresh; with a 15 minute threshold latency; a 10 km threshold resolution by using the radiance values; with 5 km threshold mapping uncertainty; over the range of heights contributions of 0-5 layers (TBS) and thickness by general cloud type, and with TBS accuracy on thickness and height.

ID:
5835
The SW/M task will *measure* the **Cloud Layers/ Heights and Thickness: Mesoscale** determination along with ABI. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details of the threshold requirement for the **Cloud Layers/ Heights and Thickness: Mesoscale** over the 1000 km x 1000 km; with a 5 minute refresh; with a 10 minute threshold data latency; with 4 km threshold resolution by using the radiance values with TBD vertical resolution; with 2 km threshold mapping uncertainty; over the range of heights contributions of up to 5 layers (TBS) and thickness by general cloud type, and with TBS accuracy on thickness and height, and with long term stability of TBD.

ID:
1969
The SW/M task will ***contribute*** to the **Cloud Particle Size Distribution--Mesoscale** determined indirectly by ABI by contributing background temperature and moisture fields. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Cloud Particle Size Distribution--Mesoscale**: over the mesoscale; with a threshold 5 minute refresh; 1 minute data latency; 2 km spatial resolution, with Cloud Top vertical resolution; over the range of 0 - 50 µm, with an accuracy of 4 µm; and 1.0 km mapping accuracy.

ID:
2011
The SW/M task will *contribute* to the **Cloud Top Height--Mesoscale** determination along with ABI. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Cloud Top Height--Mesoscale** over the 1000 km x 1000 km mesoscale; contributing a threshold 5 minute refresh; with a 15 minute threshold latency; at 4 km threshold resolution by using the radiance values; with vertical resolution of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km; using 2 km threshold mapping

uncertainty; over then range of heights of 0 - 20 km; with measurement accuracy of surface to 500 mb: 0.3-0.5 km, 500 to 300 mb: 1-2 km.

ID:
2012
The SW/M task will *contribute* to the **Cloud Top Temperature--Mesoscale** determined by ABI by contributing background temperature and moisture fields. The background fields are collected over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Cloud Top Temperature--Mesoscale**: over the 1000 km x 1000 km mesoscale; with a threshold 5 minute refresh; 1 minute data latency; 2 km spatial resolution, with Cloud Top vertical resolution; over the range of 180 - 300 K, with an accuracy of 1.0 K; and 1.0 km mapping accuracy.

ID:
2013
The SW/M task will *contribute* to the **Cloud Type--Mesoscale** determined by ABI by contributing background temperature and moisture fields. The background fields are collected over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Cloud Type--Mesoscale**: over the 1000 km x 1000 km mesoscale; with a threshold TBD refresh; TBD data latency; TBD km spatial resolution, with TBD vertical resolution; over the range of 7 types, with an accuracy of TBD; and TBD mapping accuracy.

ID:
2014
The SW/M task will *contribute* to the **Convective Initiation** determination by ABI and HES by contributing necessary high spatial and temporal resolution background temperature and moisture fields. The background fields are collected over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Convective Initiation**: over the 1000 km x 1000 km mesoscale; with a threshold 15 min refresh; 3 min data latency; 2 km spatial resolution, with TBD vertical resolution; over the range of TBD, with an accuracy of TBD; and 1 km mapping accuracy.

ID:
2015
The SW/M task will *contribute* to the **Enhanced "V"/ Overshooting Top Detection--CONUS** determination of ABI and HES by contributing necessary high spatial and temporal resolution background temperature and moisture fields. The background fields are collected over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Enhanced "V"/ Overshooting Top Detection--CONUS**: over the 1000 km x 1000 km mesoscale; with a threshold 15 min refresh; 5 min data latency; 2 km spatial resolution, with TBD

vertical resolution; over the range of 0 - 1 binary (160 - 270 K), with an accuracy of 10% detection (1 K Top); and 1 km mapping accuracy.

ID:
2016
The SW/M task will *contribute* to the **Enhanced "V"/ Overshooting Top Detection --Mesoscale** determination of ABI and HES by contributing necessary high spatial and temporal resolution background temperature and moisture fields. The background fields are collected over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Enhanced "V"/ Overshooting Top Detection --Mesoscale**: over the 1000 km x 1000 km mesoscale; with a threshold 5 min refresh; 5 min data latency; 2 km spatial resolution, with TBD vertical resolution; over the range of 0 - 1 binary (160 - 270 K); with an accuracy of 10%; and 1 km mapping accuracy.

ID:
2017
The SW/M task will *contribute* to the **Turbulence--Mesoscale** determination of ABI by contributing necessary high spatial and temporal resolution background temperature and moisture. The background fields are collected over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Turbulence--Mesoscale**: over the fill disk, with 5 min refresh rate; 5 min data latency; 2 km spatial resolution, with Sfc-500 mb: 300-500 m, 500-300 mb: 1-2 km, 300-100 mb: 1-2 km, 100 mb and above: 2-3 km vertical resolution, over the range of binary (moderate or greater (over 100 m - 4 km), with an accuracy of TBD; and 1 km mapping accuracy.

ID:
2018
The SW/M task will *measure* the **Atmospheric Vertical Moisture Profile--Mesoscale**. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Atmospheric Vertical Moisture Profile-- Mesoscale:** over the 1000 km x 1000 km; with a threshold 15 minute refresh; with a 3 minute threshold latency; at 4 km threshold resolution by using the radiance values; using 2 km threshold mapping uncertainty; over the range of 0 - 100%; employing a measurement accuracy and a layering of 10% from the surface to 500 mbar using 300 m to 500 m vertical sampling, 10% from 500 to 300 mbar using 1-2 km vertical sampling, and 20% from 300 to 100 mbar using 1-2 km vertical sampling. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
2019
The SW/M task will *measure* the **Atmospheric Vertical Temperature Profile--Mesoscale**. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty.

The following details the threshold requirement for the **Atmospheric Vertical Temperature Profile--Mesoscale**: over the 1000 km x 1000 km area; with a threshold 15 minute refresh; with a 3 minute threshold latency; at 4 km threshold resolution by using the radiance values; using 2 km threshold mapping uncertainty; over the range of 180 to 330 K employing the following layering and measurement accuracy: 0.3 to 0.5 km vertical sampling from the surface to 500 mbar, +/- 1 K from 500 to 300 mbar with 1-2 km vertical sampling, +/- 1K from 300 to 100 mbar with 1-2 km vertical sampling; and +/- 1K from 100 mbar and up with 2-3 km vertical sampling. This measurement is <u>required only in clear and above cloud regions for this instrument.</u> A microwave instrument, if present, would also contribute in cloudy regions.

ID:
2020
       The SW/M task will measure the **Capping Inversion Information--Mesoscale**. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Capping Inversion Information--Mesoscale**: over the 1000 km x 1000 km; with a threshold 15 minute refresh; with a 3 minute threshold latency; at 4 km threshold resolution by using the radiance values; using 2 km threshold mapping uncertainty; over the delta temperature range of 0-20 K (delta T and Td) with 0.5 K (TBS) accuracy. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute.

ID:
2021
       The SW/M task will *contribute* to the **Derived Stability Indices--Mesoscale** of ABI by contributing background temperature and moisture fields. The background fields are collected over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Derived Stability Indices--Mesoscale**: over the 1000 km x 1000 km; with a threshold 15 minute refresh; with a 15 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; over the range of 0 - 5000 J/kg, with a 10% accuracy.

ID:
2022
The SW/M task will *contribute* to the **Moisture Flux--Mesoscale** of HES and ABI. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Moisture Flux--Mesoscale**: over the 1000 km x 1000 km mesoscale; with a threshold 15 minute refresh; with a 3 minute threshold latency; at 4 km threshold resolution by using the radiance values; using 2 km threshold mapping uncertainty; with surface - 500 mb at 300-500 m, 500-300 mb at 1-2 km, 300-100 mb at 1-2 km, 100 mb and above at 2-3 km vertical resolution, over the range of 0-20 g/kg/hour; and with 10% accuracy. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute.

ID:
2023
The SW/M task will *contribute* to the **Pressure Profile--Mesoscale** for clear and above cloud regions only of HES if possible. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Pressure Profile--Mesoscale** for clear and above cloud regions only over the 1000 km x 1000 km; with a threshold TBD refresh; employing 0.3 to 0.5 km vertical sampling from the surface to 500 mbar, 1-2 km vertical sampling from 500 to 300 mbar, 1-2 km vertical sampling from 300 to 100 mbar, 2-3 km vertical sampling from 100 mbar and up; with TBD measurement accuracy; with a TBD threshold latency; using TBD threshold mapping accuracy; over the measurement range of TBD. This measurement is required only in clear and above cloud regions for this instrument. A microwave instrument, if present, would also contribute.

ID:
2024
The SW/M task will *contribute to* the **Total Water Content--Mesoscale**. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Total Water Content--Mesoscale** over the 1000 km x 1000 km mesoscale; with a threshold 5 minute refresh; with a 5 minute threshold latency; at 4 km threshold resolution by using the radiance values; using 2 km threshold mapping uncertainty; over the total vertical column (surface to TOA); over the range of 0-100 mm; and with TBD accuracy. This measurement is <u>required only in clear and above cloud regions for this instrument</u>. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
2025
The SW/M task will *contribute to* the **Clear Sky Masks--CONUS** determinations for the SW/M task using the temperature and visible band. The SW/M task collects over the 5000 km x 3000 km mesoscale with a threshold 70 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution (1 km visible resolution); using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Clear Sky Masks--CONUS**: over the 5000 km x 3000 km CONUS; with a threshold 15 minute refresh; with a 15 minute threshold latency; at 2 km threshold resolution; with 1 km threshold mapping uncertainty; with TBD vertical resolution; over the range of 0 - 1 binary; and with 10% accuracy.

ID:
2026
The SW/M task will *contribute to* the **Clear Sky Masks--Mesoscale** determinations of ABI for the SW/M task using the temperature and visible band. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Clear Sky Masks--Mesoscale**: over the 1000 km x 1000 km mesoscale; with a threshold 5 minute refresh; with a 5 minute threshold latency; at 2 km threshold resolution by using the

radiance values; using 1 km threshold mapping uncertainty; with TBD vertical resolution; over the range of 0 - 1 binary; and with 10% accuracy.

ID:
2027

The SW/M task will *measure* the **Radiance--Mesoscale** and will contribute to the measurements from ABI. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Radiance--Mesoscale**: over the 1000 km x 1000 km mesoscale; 60 minute refresh; 30 minute data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty; with vertical sampling and layering of 300-500 m from the surface -500 mb, 1-2 km from 500-300 mb, 1-2 km from 300-100 mb, and 2-3 km from 100 mb and up; over the range of 180-330K; and with TBD accuracy. This measurement is <u>required only in clear and above cloud regions for this instrument</u>. A microwave instrument, if present, would also contribute in cloudy regions.

ID:
2028

The SW/M task will *contribute* to the **Derived Motion Winds--Mesoscale** of ABI to supply background temperature and moisture fields. The background fields are collected over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Derived Motion Winds--Mesoscale**: over the 1000 km x 1000 km mesoscale; with a threshold 5 minute refresh; with a 3 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; with 4 level vertical resolution (Low, Mid, Mid-High, High); over the range of 0 - 300 knots (0 - 155 m/sec); and with an accuracy of Low level: 2.5 m/s, Mid level 4 m/s, High level: 6 m/s.

ID:
2029

The SW/M task will *contribute* to the **Microburst winds** of ABI to supply background temperature and moisture fields. The background fields are collected over the 3000 km x 5000 km CONUS with a 70 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirements for **Microburst winds**: over the 5000 km x 3000 km CONUS; with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution; with 5 km threshold mapping uncertainty; with TBD vertical resolution; over the range of TBD; and with TBD accuracy.

ID:
2030

The SW/M task will *contribute* to the **Flood Standing Water--Mesoscale** of ABI by supplying surface emissivity. The SW/M task collects over the 1000 km x 1000 km mesoscale with a threshold 4.4 minute refresh; with a 3 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Flood Standing Water--**

Mesoscale: over the full disk; at 10 km spatial resolution, 60 minute refresh rate, 5 km mapping accuracy, and 6 hour threshold latency; with 5 cm vertical resolution, with 0 - 100% measurement range, and n/a accuracy.

ID:
2031
The OO task will meet the following observational requirements detailed in the GPRD-1. (See section 2.11.3 for relevant comments.) Goal values are currently listed in Appendix A.

ID:
2032
The OO task will *contribute to* determinations of the **Currents-Hemispheric** by ABI. The OO task collects over the 62 degree LZA disk with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Currents---Hemispheric**: over the full disk; with a threshold 6 hours refresh; with a 60 threshold latency; with vertical resolution of at the surface; supporting 2 km threshold resolution of ABI by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 5 m/sec (0 - 18 km/hour) with a direction of 0 to 360 degrees; and with 1.0 km/hour accuracy.

ID:
2033
The OO task will *contribute to* determinations of the **Currents---CONUS** by ABI. The OO task collects over the 62 degree LZA disk with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Currents---CONUS**: over the 3000 km x 5000 km CONUS; with a threshold 180 minute refresh; with a 60 minute threshold latency; 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 5 m/sec (0 - 18 km/hour) with a direction of 0 to 360 degrees; and with 2 m/sec accuracy.

ID:
2034
The OO task will *contribute to* determinations of the **Currents--Mesoscale** by ABI. The OO task collects over the 62 degree LZA disk with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Currents--Mesoscale**: over the 1000 km x 1000 km mesoscale; with a threshold 6 hour refresh; with a 60 minute threshold latency; at supporting 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 5 m/sec (0 - 18 km/hour); and with 1.0 km/hour accuracy.

ID:
6366
The OO task will *contribute to* determinations of **Ocean Color: Offshore (Turbidity/Chlorophyll/ Reflectance) Turbidity--Hemispheric**. The OO task collects over the 62 degree LZA disk with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 4 km

threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Ocean Color: Offshore (Turbidity/Chlorophyll/ Reflectance) Turbidity-Hemispheric**: over the 62 degree LZA; with a threshold TBS minute refresh; with a TBS minute threshold latency; at 100 km threshold resolution by using the radiance values; using TBS km threshold mapping uncertainty; over the range of TBS.

ID:
2035
The OO task will *contribute to* determinations of **Ocean Turbidity--Hemispheric**. The OO task collects over the 62 degree LZA disk with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Ocean Turbidity--Hemispheric**: over the 62 degree LZA; with a threshold 3 hour refresh, a 60 minute latency, at 5.0 km threshold resolution, over a total range of 0 to -10 meters, 2.0 km mapping uncertainty, over the threshold range for 0-100 mg/m^3 with a measurement accuracy of $< 30\%$.

ID:
2036
The OO task will *contribute to* the **Sea and Lake Ice Age--Hemispheric** determinations of ABI. The OO task collects over the 62 degree LZA disk with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 4 km threshold resolution; using 2 km threshold mapping uncertainty. The following details the threshold requirement for the **Sea and Lake Ice Age--Hemispheric:** over the full disk; with a threshold 6 hour refresh; with a 60 minute threshold latency; at 3 km threshold resolution by using the radiance values; using 1 km threshold mapping uncertainty; over the range of distinguish between ice free areas and first year ice.

ID:
2037
The CW task will meet the following observational requirements detailed in the GPRD-1 (See section 2.11.3 for relevant comments.) Goal values are currently listed in Appendix A.
Note that the usage of "coastal" and "offshore" below together equate to the usage of coastal in the rest of this document.

ID:
2038
The CW task will *measure* the **Cloud Imagery--"Coastal"** determination of HES-CW together with ABI during the day and ABI at night. The CW task collects over the US Navigable waters through the EEZ, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Cloud Imagery--"Coastal"**: over the US Navigable waters through the EEZ; with a threshold 180 minute refresh; with a 15 minute threshold data latency; at 1 km threshold resolution (day) and 2 km threshold resolution (night) by using imagery; using $< / = 1$ km threshold mapping uncertainty; over the range of TBD; and with n/a measurement accuracy.

ID:
2039

The CW task will *contribute* to **Visibility--"Coastal"** determination of ABI by contributing background temperature and moisture fields. The CW task collects over the US navigable waters through the EEZ, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Visibility--"Coastal":** over the US navigable waters though the EEZ; with a threshold 3 hour refresh; with a 15 minute threshold latency; at 3 km threshold resolution by using temperature and moisture profiles; using < 3 km threshold mapping uncertainty; over the range 0-3.2 km; and with a TBD accuracy.

ID:
2040
The CW task will *contribute to* the **Clear Sky Masks--CONUS** determinations for the CW task using the temperature from the HES-CW task and the visible band. The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Clear Sky Masks--CONUS:** over the US navigable waters through the EEZ; with a threshold 15 minute refresh, a 15 minute latency, at 2 km threshold resolution, over TBD vertical resolution, 1 km mapping uncertainty, over the threshold range of 0 - 1 binary; with a measurement accuracy of 10%.

ID:
2041
The CW task will *measure* the **Currents--Mesoscale.** The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Currents--Mesoscale:** over the 1000 km x 400 km (US navigable waters through the EEZ width); with a threshold 6 hours refresh; with a TBD threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 5 m/sec (0-18 km/hour) and direction of 0 - 360 degrees; and with 1.0 km/hour accuracy.

ID:
2042
The CW task will *contribute to* determinations of the **Currents--"Offshore" / CONUS.** The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Currents--"Offshore" / CONUS:** over the 1000 km x 400 km within the CONUS; with a threshold 3 hours refresh; with a 60 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0-1.8 km/hour; and with 1.0 km/hour accuracy.

ID:
2043
The CW task will *contribute to* determinations of **Ocean Color (Turbidity/Chlorophyll/Reflectance)--"Coastal"** in the coastal region (inside the EEZ). The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution;

using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Ocean Color (Turbidity/Chlorophyll/Reflectance)--"Coastal":** (inside the EEZ): with a threshold 3-hour refresh, a 60 minute latency, at 0.3 km threshold resolution, 0.3 km mapping uncertainty, over the threshold range for water leaving radiances (all TBSs) of 0.01-1 mW cm^{-2} μm^{-1} sr^{-1}, for Chlorophyll concentrations of 10^{-3} - 10^2 microgram/liter, for Turbidity of 10^{-4} - 0.15 sr^{-1}m and reflectance of 10^{-4} - 0.15 sr^{-1}, with < 30% accuracy.

ID:
5839
The CW task will *contribute to* determinations of **Ocean Color (Turbidity/Chlorophyll/Reflectance)--"Offshore"** in the coastal region (inside the EEZ). The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Ocean Color (Turbidity/Chlorophyll/Reflectance)--"Offshore"** (inside the EEZ): with a threshold 24-hour refresh, a 1-hour latency, at 100 km threshold resolution, TBD mapping uncertainty, over the TBD threshold range for water leaving radiances; with TBD accuracy.

ID:
2044
The CW task will *contribute to* determinations of **Ocean Optical Properties -"Coastal" (Particulate absorption, backscatter, fluorescence)** in the coastal region (inside the EEZ). The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Ocean Optical Properties--"Coastal" (Particulate absorption, backscatter, fluorescence)** (inside the EEZ): with a threshold 3-hour refresh; a 30 minute latency, at 0.3 km threshold resolution; 0.3 km mapping uncertainty; depth of (TBS), over the threshold ranges (all TBSs) of Absorption 0.01-10 m^{-1}, Scattering 0.01-50 m^{-1}, no Chlorophyll fluorescence, and with < 30% accuracy.

ID:
2045
The CW task will *contribute to* determinations of **Ocean Optical Properties--"Offshore" (Particulate absorption, backscatter, fluorescence)** (inside the EEZ). The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Ocean Optical Properties --"Offshore" (Particulate absorption, backscatter, fluorescence)** (inside the EEZ): over the US navigable waters through the EEZ width; with a threshold 24-hour refresh; a 1 hour latency, at 1.0 km threshold resolution; 1.0 km mapping uncertainty; depth of TBD; over the threshold ranges (all TBSs) of Absorption 0.01-10 m^{-1}, Scattering 0.01-50 m^{-1}, no Chlorophyll, and with < 30% accuracy.

ID:
2046
Removed

ID:

6583

The CW task may contribute to the determinations of the **Sea Surface Temperature--CONUS** of ABI if tasked. The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Sea Surface Temperature--CONUS:** over the 1000 km x 400 km (US navigable waters through the EEZ width); with a threshold 3 hour refresh; with a 1 hour threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 270 - 313 K; and with 1 K accuracy.

ID:

6584

The CW task may contribute to the determinations of the **Sea Surface Temperature--Mesoscale** of ABI if tasked. The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Sea Surface Temperature--Mesoscale:** over the 1000 km x 400 km (US navigable waters through the EEZ width); with a threshold 60 minute refresh; with a 15 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 270 - 313 K; and with 1 K accuracy.

ID:

2048

The CW task could *contribute to* determinations of the **Vegetation Fraction--Green** of ABI regionally, if tasked. The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Vegetation Fraction--Green**: over the CONUS; with a threshold 60 minute refresh; with a 60 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 1 (unitless); and with an accuracy of 0.05 (unitless).

ID:

2049

The CW task could *contribute to* determinations of the **Vegetation Index--CONUS** of ABI regionally, if tasked. The CW task collects over the US navigable waters, with a threshold 3 hour refresh; with a 15 minute threshold data latency; at 0.3 km threshold resolution; using 0.15 km threshold mapping uncertainty. The following details the threshold requirement for the **Vegetation Index--CONUS:** over the CONUS; with a threshold 60 minute refresh; with a 60 minute threshold latency; at 2 km threshold resolution by using the radiance values; using 1.0 km threshold mapping uncertainty; over the range of 0 - 1 (NDVI units); and with an accuracy of 0.04 (NDVI units).

ID:

2051

(2.10.2) 3.A. Top Priority Requirements

ID:
2052
The following two threshold requirements (3.A.1 and 3.A.2) are considered the highest priority improvements by the National Weather Service for the DS and SW/M tasks of the HES (although the priorities are also relevant to the environmental imaging tasks for the OO, and CW) relative to the GOES I-M series:

ID:
2053

(2.10.2) 3.A.1. Operation during eclipse and keep out zone periods

ID:
2054
The HES shall be capable of continuous operation during eclipse periods in geostationary orbit and shall meet all requirements except for navigation, where all navigation requirements are described in section (2.10.2) 3.B.15.1.

ID:
2055
The daily period of time prior to and following spacecraft eclipse and during the seasonal periods just prior to and after eclipse when sunlight impinges on the HES optical path(s) is commonly called the keep-out-zone period. The translation of these time periods to angular space results in the description of the operational zone, the restricted performance zone and the keep-out zone. The HES shall meet all of its operational requirements for all detector elements greater than the THRESHOLD limits shown here from the center of the uneclipsed sun. The HES <u>should</u> meet all of its operational requirements for all pixels greater than the GOAL limits shown here from the center of the uneclipsed sun. Outside of this limit lies the operational zone.

Channel	Outer Limit (THRESHOLD)	Outer Limit (GOAL)
Emitted IR bands (650-2720 cm^{-1}, 15.4 to 3.68 um)	10° (TBR)	5° (TBR)
Reflected Solar (0.4-3.0 um)	10° (TBR)	5° (TBR)
Low light	10° (TBR)	5° (TBR)

ID:
2073
The restricted performance zone lies between the outer limit in the table above and the inner limit of the table below. The HES **shall** meet all requirements, except the NEdN and On-Orbit calibration and accuracy, for all detector elements for the Threshold limits between the outer limit in the table above and the inner limit of the table below, as measured from the center of the uneclipsed sun. The HES <u>should</u> meet all requirements, except the NEDN and On-Orbit calibration and accuracy, for all detector

elements for the GOAL limits between the outer limit in the table above and the inner limit of the table below, as measured from the center of the uneclipsed sun.

Channel	Inner Limit (THRESHOLD)	Inner Limit (GOAL)
Emitted IR bands (650-2720 cm^{-1}, 15.4 to 3.68 um)	3° (TBR)	2° (TBR)
Reflected Solar (0.4-3.0 um)	3° (TBR)	2° (TBR)
Low light	3° (TBR)	2° (TBR)

ID:
2091
Reflected solar (<3 microns) except for star sensing, are not applicable over the coverage area whenever any point on the coverage area falls within +/- 2.5 hours centered on local midnight.

ID:
2092
In place of the NEdN, dynamic range, and On-Orbit calibration and accuracy sections, the HES shall meet the following requirements:

ID:
2093
- NEDN < 2x normal specification

ID:
2094

ID:
2095

ID:
2096
No detector shall saturate.

ID:
2097
The calibration performance shall degrade by no more that TBD (THRESHOLD) and 0.5 K (Goal).

ID:
2098
Discussion: Geostationary viewing geometry results in sunlight impingement on the optical path of the GOES HES telescope(s) during the periods of the year several weeks around each equinox. When this happens, stray sunlight may cause a degradation of the radiometric response accuracy of the sounder's

Earth-viewing detectors, as well as heating of the telescope(s). How much degradation and how long this effect lasts will depend on many design features of the HES. The HES should be designed in such a way that intrusion of sunlight from outside the field of view is minimized, reducing as much as is practical the need for "keep-out zones" near local midnight during the equinoxes, and in addition minimize heating of telescope(s) mirrors and mounts. Ground operations maintain a prohibition against scanning within 1.4 (TBR) degrees of the sun center under routine operating conditions to prevent HES instrument damage. Focused sunlight on the optics is a cause of potential damage. The energy is sufficient to damage optical materials and coatings, and to irreparably damage detectors. Any detector within 3 degrees of the sun (TBR) is not required to provide useful data. The relaxation of requirements between 3 (TBR) and 10 (TBR) degrees of the sun threshold (between 2 (TBR) and 5 (TBR) degrees goal) is done in recognition that stray light will degrade performance in the local midnight condition. A JPL February 2000 report ("Keep-Out Zone Specification for the Advanced Baseline Imager and Background Discussion,") has documented the initial numbers used in this requirement.

ID:
2099
   Benefits: There is a need for near-continuous coverage for IR data, including both spring severe weather and fall hurricane seasons.

ID:
2100

(2.10.2) 3.A.2. Improve DS task spatial coverage (and addition of other coverage tasks).

ID:
2101
The instrument performing the DS task shall produce data (while meeting all on-orbit calibration and navigation requirements) with the coverage rate specified below:

ID:
2102

Local Zenith Angle=~62 Degrees

CURRENT HOURLY GOES SOUNDER COVERAGE
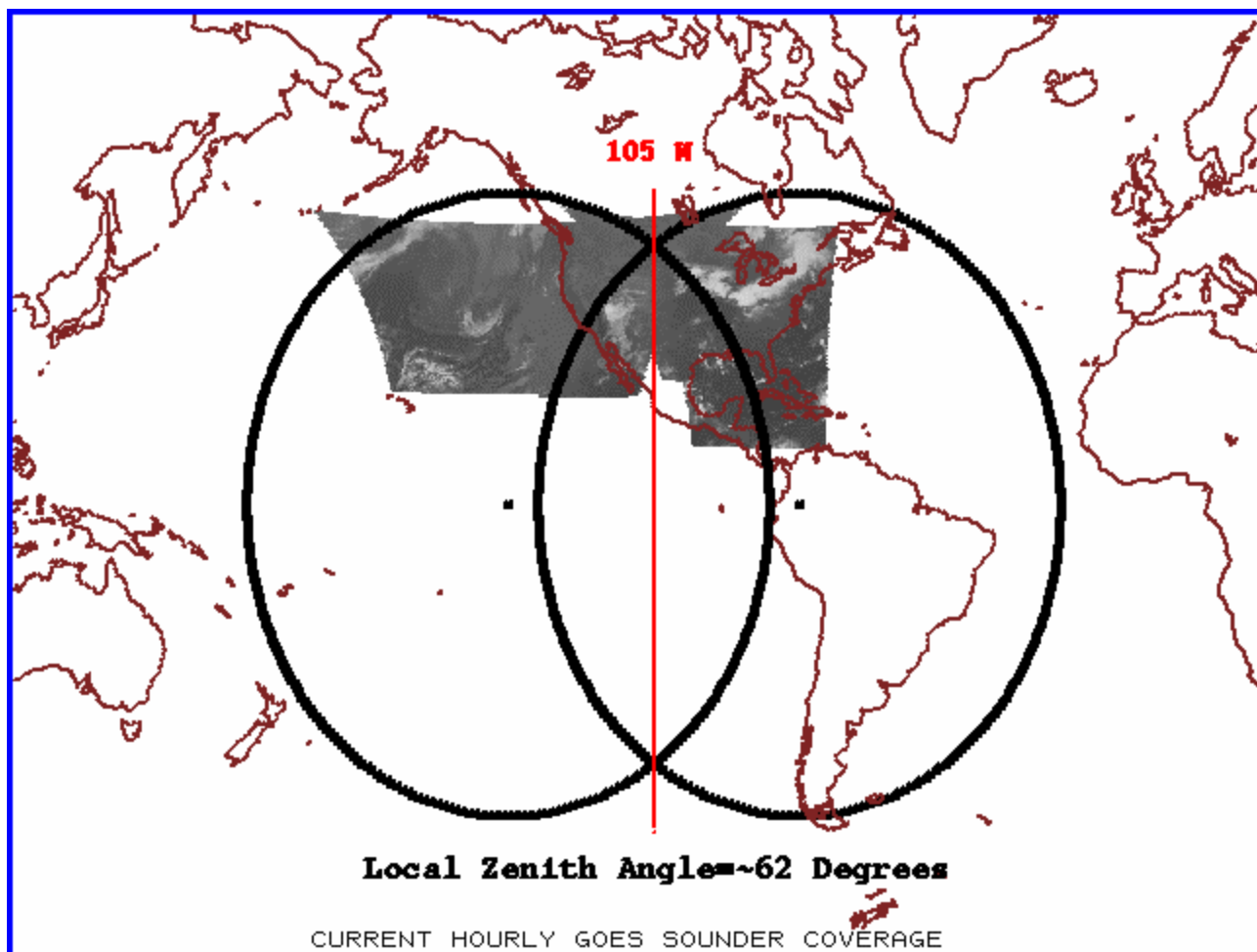
ID:
2103
Figure 1. Shown are the approximate areas of 62 degrees local zenith angle from both the GOES-East and GOES-West sub-satellite points. The threshold coverage rate calls for the region within the 62-degree arc, excluding half of the overlap region, to be scanned each hour. For information only, an image for one hour of the infrared window from the current generation instruments is shown. The 62-degree local zenith angle (LZA) coverage for the DS task is about 5 times larger than the coverage from the current generation sounder over the same period.

ID:
2104
a) Scan the region within 62-degrees local zenith angle (although only scan half of the region of overlap between the eastern and western satellites, nominally at 105W) within one hour (see Figure 1). (THRESHOLD) For the threshold resolution for this task of 10 km, as discussed in section (2.10.2) 3.B.2.d, an associated ground sample rate (GSR) providing nominally constant noise performance can be defined. It is the coverage rate just discussed R_{cov} divided by ($A_{pix}*\varepsilon_{scan}$) where A_{pix} is the product pixel area and εscan is the scan efficiency which includes overlap to avoid gaps, image rotation, number of calibrations needed during the scan, and step and settle limitations of the scan mirror. With R_{cov} = 2.0e4 km2/sec, the threshold GSR shall be 195 (TBR), defined with a scan efficiency of 1.0. For the

same parameters and an ε_{scan}=0.8, the sensor GSR will be 240 Hz (TBR) to achieve the 195 Hz GSR requirement.

ID:
2105
Scan the full earth disk in one hour (GOAL) which implies a ground sample rate of 272 Hz (TBR) for the 10 km spatial sample, defined with a scan efficiency of 1.0. For the same parameters and an ε_{scan}=0.8, the sensor GSR will be 340 Hz (TBR) to achieve the 272 Hz GSR requirement. If a finer spatial resolution is employed to approach the goal of that requirement, a smaller A_{pix} results which can be compared against the goal GSR expressed as 27000/A_{pix}.

ID:
2106
c) The scan area shall be selectable to offer flexible scan scenarios. This ranges from mesoscale areas (1000 km by 1000 km) through the size of the full disk, using the 62 degree LZA ground sample rate described in item a in this list. If the DS task is performed by a separate instrument than the instrument performing the SW/M task, then the instrument performing the DS task must still offer flexible scan scenarios for backup purposes, although the instrument performing the SW/M task will provide the 1000 km x 1000 km coverage (THRESHOLD). If the same instrument performs the DS and SW/M tasks, the scan efficiencies discussed in a above may be slightly different, but the ground sample rate is an instrument capability for noise performance that will apply to both.

ID:
2107

ID:
2108
d) Overall task efficiency bearing on the DS task:

ID:
2109
As a THRESHOLD the DS task instrument(s) **shall** continuously perform either a DS scan *or* a SW/M scan.

ID:
2111
As a GOAL, the sounding task instrument(s) should be capable of continuously and concurrently performing both a DS scan *and* a SW/M scan.

ID:
2112
The instrument performing the SW/M task shall produce data (while meeting all on-orbit calibration and navigation requirements) with the coverage specified below:

ID:

2113

Mesoscale (1000 km x 1000 km) sounding coverage in 4.4 (TBR) minutes (THRESHOLD) and a refresh rate of 4.4 (TBR) minutes. If a CONUS-sized area of 5000 km x 3000 km were selected, the refresh rate for this area would therefore be 15 times longer at 66 minutes (TBR). This task will be performed subsequently to any other pre-assigned tasks of this instrument.

ID:

2114

Mesoscale (1000 km x 1000 km) sounding coverage in 2 (TBR) minutes (GOAL) with a refresh rate of 2 (TBR) minutes (TBR) in addition to meeting its other pre-assigned tasks.

ID:

2115

Mesoscale (1000 km x 1000 km) images (GOAL) in the visible band and near 11.2 um with 30 second refresh.

ID:

2116

The scan area shall be selectable and flexible.
If the SW/M task is not performed by the same instrument as that performing the DS task, a larger value for the ground coverage rate for the SW/M sounding task may be realizable.

ID:

2117

e) Overall task efficiency bearing on the SW/M task:

ID:

2118

As a THRESHOLD the SW/M task instrument(s) shall continuously perform either a DS scan *or* a SW/M scan.

ID:

2119

The time to switch between HES sounding tasks shall be 25 (TBR) seconds or less. (Under review)

ID:

2120

As a GOAL, the sounding task instrument(s) <u>should</u> be capable of continuously and concurrently performing both a DS scan *and* a SW/M scan.

ID:

2121

The instrument performing the OO task shall produce data (<u>while meeting all on-orbit calibration and navigation requirements</u>) with the coverage specified below:

ID:

2122
a.   Coverage of open ocean area lying within the 62 degree LZA, which is approximately 6.8e7 km (TBR) in 3 hours TBR (THRESHOLD) in addition to meeting its other pre-assigned tasks. This meets the most restrictive THRESHOLD time requirement from the GPRD-1 for offshore currents.

ID:
2123
Coverage of open ocean area lying within the 62 degree LZA, which is approximately 6.8e7 km^2 (TBR) in hour (GOAL) in addition to meeting its other pre-assigned tasks. This meets the most restrictive GOAL time requirements from the GPRD-1 for offshore currents.

ID:
2124
The scan area shall be selectable to offer flexible scan scenarios.

ID:
2125
The instrument performing the CW task shall produce data (<u>while meeting all on-orbit calibration and navigation requirements</u>) with the coverage specified below:

ID:
2126
400 km wide (~22.22 km of the territorial sea originating at the low tide water line and the additional 370.4 km from the outer edge of the territorial sea to the to the Exclusive Economic Zone) along the length of the coast (US east and gulf coasts ~6000 km, US west coast and Hawaii ~3300 km totaling ~2.4e6 km^2 (TBR) when including the 400 km width) in 3 hours TBR (THRESHOLD) in addition to meeting its other pre-assigned tasks. This meets the most restrictive THRESHOLD time requirement from the GPRD-1 for coastal currents.

ID:
2127
Coverage area specified above (in item 2126) in 60 minutes. This meets the most restrictive GOAL time requirement from the GPRD-1 for coastal currents.

ID:
2128
The scan area shall be selectable to offer flexible scan scenarios, including 1) a 1200 km x 1200 km area ("HES localized mode 570" nm, under study) within CONUS that is observed primarily outside HEW-CW observing times and 2) a 400 km x 400 km area ("HES localized mode").

ID:
2129
As a THRESHOLD, the CW task instrument(s) shall continuously perform CW scans by executing on of its modes (i.e. as defined in ID 2121). Continuously implies that the coverage rate will be met.

ID:

Eastern full disk

Central full disk

30

"Wing" coverage area (light gray) for imaging and sounding in backup mode, in addition to sounding coverage of 62 degree LZA. Wing area listed above. Wing width is shown with solid line.
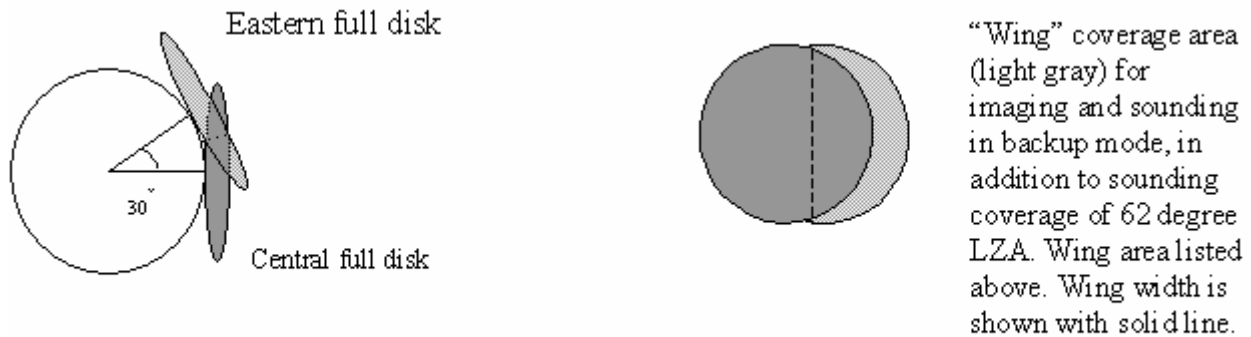
2130
ABI Backup mode (HES THRESHOLD across all tasks) (TBR): If ABI fails, HES must provide a backup, albeit with degraded capability compared to ABI. Images will be produced within a period of 30 minutes or less from the area of either the western or eastern full disk view that is not covered by a central full disk view (nominally 1.91e7 km^2 as shown in Figure 1a and known as the "wing" with a maximum width of 2806 km). The spatial resolution shall be no coarser that 4 km in the IR and 1 km in the visible. Soundings over the 62 degree LZA shall meet all requirements of the DS task (TBR) except the NEdN, which will be what the vendor can provide. "What the vendor can provide" shall include the subset of ABI band coverage in the visible band, reflected solar < 1 um (or reflective solar < 3 um), as well as the IR portion of the sounder (THRESHOLD). For soundings, the backup mode shall not preclude the usage of the SW/M task. The backup mode shall not preclude the usage of the HES-CW task. As a GOAL, the HES should provide, when imaging, the noise performance of the subset of ABI bands contained in the vendor's HES; and should provide for sounding the noise performance of 2*NEdN (TBR) of the DS task. (GOAL).

Discussion: HES-CW task will not typically be employed during the ABI backup mode, although use of the ABI backup mode will not preclude its usage for a special event.

ID:
5777
<Picture>

ID:
2131
Figure 1a. (Left) Polar view of earth showing eastern full disk coverage and central full disk coverage in a failure scenario for the western A satellite in the distributed architecture. (Right) Equatorial view of ABI coverage from central disk and HES backup mode coverage (or "wing" coverage) from the eastern satellite.

ID:
2132
Discussion: The THRESHOLD requirement does not mean the operational schedule for the instrument assigned to the DS task will simply consist of sequential nearly full disk "sounding" images. It does set a

threshold ground sample rate for this instrument of 62 degrees local zenith angle in one hour including all on-board calibration and navigation, which will afford a coverage rate than can be used to make non-full disk observations. (Because the ground sample rate can also be understood in terms of nominally constant noise performance, it is helpful in understanding that moving to smaller pixels that the threshold DS value lead to smaller coverage areas as a consequence of the longer associated integration time.) The CONtinental United States (CONUS) area (defined approximately as the geographic area encompassing 10N-60N latitude and 60W-125W longitude), or the equivalent of a nadir-viewed rectangle 5000x3000 kilometers in dimension may be scanned more frequently, allowing more clear observations as clouds move. Clear observations yield better retrievals but there is interest in retrievals in the air over clouds. Southern Hemisphere oceanic regions may be scanned less frequently, which would allow observations over large regions without conventional observations (i.e., the Pacific Ocean). *If the SW/M task is met with a separate instrument than that performing the DS task, then the instrument providing the DS task will concentrate on the 62-degree disk to support global modeling.*

ID:
2133
At this point, the full impact of the faster full disk coverage performance goal of one hour on the advanced sounder design and requisite technologies may be a system driver. NOAA/NESDIS, with NASA, continues to guide engineering studies at FFRDCs (Federally Funded Research and Development Centers) to explore advanced HES design and concepts directed at faster coverage rates. The threshold-scanning requirement is somewhat more than 2½ times faster than the coverage rate of the 5000 km x 3000 km per half hour of the first HES (formerly the first ABS) design. The coverage rate of 62-degree local zenith angle in one hour represents at least a factor of five increase over that of the current filter wheel sounder. The thrust of NOAA's NWS sounder scanning needs is to cover both CONUS and large coastal and open ocean areas, particularly in the Pacific. Tropical cyclone coverage is needed as well. The major technology areas to be explored for the increased coverage rate are: increased aperture size, increased number of detectors and focal plane array (FPA) size, and mechanical cooling for an operational instrument. Increased coverage rates directly impact NEdN, A/D converter requirements, and data rates.

ID:
2134
Current WMO guidance calls for an *optimum* repeat cycle of one hour of sounder coverage for global Numerical Weather Prediction (NWP). The faster end of their median range (one level down from optimal) is 2.3 hours.**

ID:
2135
Over the next decade, national-domain NWP models will move from an age where many of the physical processes simulated by the models were approximated statistically and the resolution of the forecast models was notably *coarser* than that of geostationary soundings and into an era when most of the physical processes in the models will be treated explicitly and at a resolution *finer* than that of the current generation of satellite observations. For example, the Nested Grid Model was implemented in 1986 with a horizontal resolution of 85 km; the current Eta model has 12 km horizontal resolution as of May 2002. This resolution will be approximately nine times finer than the resolution available from the current GOES -I/M and GOES-N/Q sounders. By 2010, the resolution of national domain NWP models

will approach 5 km and the models will likely be non-hydrostatic. These models will require higher-space and time-resolution observations and can use these higher-resolution data in new ways (e.g., specifying cloud droplet distributions). Continued improvements in NWP model resolution will occur thereafter, necessitating even higher resolution data as input. Global models by comparison are anticipated to have about 35 km spatial resolution in 2010. This is part of the motivation to list the SW/M tasks separately from that of the DS task. (It should be noted that each halving of grid spacing requires over a 10-fold increase in computer power. The expected model resolution improvements are consistent in direction with the increases in computing power predicted by industry during this period, although not as rapid due to the increases in detail associated with improvements in parameterization.)

ID:
2136
The mesoscale data supporting these forecast systems will come primarily from two operational observing systems, doppler radar and geostationary satellites. While the doppler radar will provide 1-2 km resolution precipitation and wind information *after* clouds are already present, the geostationary sounders will be the primary source of localized moisture and temperature (stability) data in clear air *before* the storms develop, as well as information about cloud top structures. These data sets provide natural complements to each other. For example, it has been shown that non-hydrostatic models can do credible jobs of forecasting the short-range evolution of convective systems once they are mature enough to be detected by doppler radar. However, satellite depictions of rapidly changing low-level moisture and stability patterns will be critical in determining the timing and location of the onset of localized convection. This is the motivation for calling out the SW/M as a separate task to sample the clear air in advance of the storm formation. Since the sounder data set and the doppler radar data sets will be used in concert, in the long-term they must be of consistent spatial resolution over the CONUS since this is where the doppler radar exists.

ID:
2137
Although the initial, minimal "Threshold" requirements for independent, 10-km, geostationary moisture and temperature observations are of approximately the same order of magnitude as the expected model resolution in 2010, some features that will be already included in the forecast model at that time may already start to be under-represented in the satellite data. For example, strong low-moisture gradients produced across several kilometers by local variations in antecedent precipitation produced by the model's surface evaporation systems could begin to appear overly smoothed in the 10-km satellite data. Similarly, the structures of clouds being forecast to cover 3 or 4 grid boxes by the model and observed by the GOES imager could be unresolved by the high-spectral resolution instrument meeting the DS task. The SW/M task consequently has improved spatial resolution.

ID:
2138
As model resolution and physical realism continue to increase beyond 2010, the impact of the geostationary sounder data from a "threshold system" performing the DS task only will diminish unless the resolution of the observations keeps pace with the increased model resolution and approaches that of the complementary radar data sets, which is addressed when the SW/M task is met. These higher-resolution satellite sounding data will become increasingly critical in improving forecasts of the timing and location of the onset of hazardous weather events ranging from severe convection to localized heavy

icing. For example, soundings obtained in the small areas between developing cumulus clouds will be needed to provide a continuous detailed picture of upstream moisture and stability patterns for forecasting and nowcasting systems, as well as direct forecaster use. To obtain the kinds of observations that assure continued impact of geostationary sounder data beyond 2020, the documented NOAA's NWS performance Threshold task of SW/M, at the goal spatial resolution of the DS task, is desirable as soon as technically and financially feasible in order to assure an evolutionary observing system improvement path that continually incorporates technological advances which support NOAA's NWS forecast improvement goals at minimal cost.

ID:
2139
Benefits: This spatial coverage rate allows for generation of the satellite radiances and products frequently over the CONUS region for forecasters and regional numerical models, plus allowing greater oceanic coverage for assimilation into global numerical models. Benefits of improved spatial resolution are discussed above as well as in section (2.10.2) 3.B.2.d.

ID:
2140

(2.10.2) 3.B.Additional HES Requirements

ID:
2141
Table 1 describes the retrieval accuracy required from the DS task and SW/M Sounding task for information only, and to tie to NOAA's NWS requirements. Note that 1) the vertical resolution listed by NOAA's NWS reflects vertical sampling 2) the "100 hPa and above" listed below by NWS is essentially to 1 hPa and 3) there is an interest in soundings in air above the clouds and consequently the retrievals from such a region may be impacted by additional uncertainties from cloud signal interaction.

ID:
2142
This MRD ties instrument requirements to these retrieval accuracies. Radiances are described in subsequent sections of this document. The need for all weather soundings will be partially addressed by a microwave instrument that is P^3I for GOES-R and partially addressed for sounding from the HES. For the HES, there is an interest in soundings in air above the clouds and consequently the retrievals from such a region may be impacted by additional uncertainties from cloud signal interaction. The NEdN values listed later in this document reflect noise performance in clear air conditions only. Goal NEdN values in the shortwave infrared have also been listed to address sounding in the presence of partial cloud cover.

ID:
2143
Tables 2a, 2b, 2 c, 2d, and 2e area partial summary, for convenience, of the THRESHOLD requirements for the DS, SW/M, OO and CW tasks respectively. More detail can be found on each of these topics in the corresponding sections of the document.

ID:
5430
Table 1. Sounding Performance Summary: Accuracies and vertical "resolution" in clear air *provided for information only*. See note above for important clarifications for this table.

Altitude Range	Observational Accuracy		Observational Accuracy		Vertical Resolution	
	Temperature THRES-HOLD	Temperature GOAL	Humidity THRES-HOLD	Humidity GOAL	THRESHOLD	GOAL
Surface - 300 hPa	+/-1.0 K	+/- 0.5 K	+/- 10%	+/- 5%	Surface-500 hPa; 0.3-0.5 km layers 500 - 300 hPa 1 - 2 km layers	Surface-500 hPa; < 0.3 - 0.5 km layers, 500-300 hPa; <1-2km layers
300 hPa - 100 hPa	+/- 1.0 K	+/- 0.5 K	+/- 20%	+/- 10%	1 - 2 km layers	< 1 - 2 km layers
100 hPa and above	+/- 1.0 K	+/- 0.5 K	N/A	N/A	2 - 3 km layers	< 2 - 3 km layers

ID: 5469

Table 2a. HES DS Task Observational Requirements Parameters Summary (Partial List)

Requirement and Source		Threshold
Spatial resolution*	Visible	1 km IFOV on a centroid to centroid distance of 1 km (see 3.B.2.d) to enable cloud-cover detection including low-light situations
	IR	10 km on a centroid to centroid distance of 10 km (280 urad (THRESHOLD), 2 km on a centroid to centroid distance of 2 km (GOAL) (see 3.B.2.d)
Detector-Optics Ensquared energy (all bands)**		See 3.B.2.e and Table 3c. and Table 3d. therein
Spatial coverage rate	The region within 62 degrees local zenith angle (except only half of the overlap region between two satellites) (Figure 1)	Each hour, including any necessary allowance for IR calibration and navigation Operational scenarios may deviate from scanning the 62 degree LZA every hour, but this coverage rate is needed to provide both CONUS and a minimum adequate level of atmospheric coverage over the data sparse oceans
	Regional and Mesoscale when required	Must be supported and selectable
Operation during eclipse*		Yes
Timeliness of data*	Radiance	3 minutes (Threshold), 1 minute (goal),
Simultaneity*		Within 10 sec. for all bands at any FOV (THRESHOLD); within 5 sec. (GOAL) (Limits cloud encroachment in FOV)
Pixel to pixel Simultaneity		Within 6 minutes for all adjacent pixels when covering 62 degree local zenith angle and within 3 minutes when covering a CONUS-sized area (THRESHOLD)
IR Spectral bands and spectral resolution, Radiometric Sensitivity, Dynamic Range**		(Tables 4a, 4aa, 4b, 6a. and 6b.)
Registration within frame* (adjacent pixels)		<= 0.5 IR IFOV at SSP (THRESHOLD); <= 0.25 IR IFOV at SSP (GOAL)
IR band linearity		See 3.B.2.j
Band to band co-registration	Visible-IR	<= 1.0 km (<= 28 urad
	IR-IR*	< 25% of IFOV (THRESHOLD) and < 10% of IFOV (GOAL)
On-orbit calibration	Visible	See 3.B.12
	IR	See 3.B.13
Lifetime***	Ground storage	5 years TBR
	On-orbit storage	5 years TBR is maximum possible
	Mean Mission Duration (MMD) life	8.4 year MMD (see section 3.B.1) TBR
	Instrument On Life	10 years at R=0.6 (see section 3.B.1)

*ID:*5547

Table 2b. HES SW/M Task Observational Requirements Parameters Summary (Partial List)

Requirement and Source		Threshold
Spatial resolution *	Visible	1 km IFOV to enable cloud-cover detection including low-light situations
	IR	4 km on a 4 km centroid to centroid distance (THRESHOLD); 2 km on a 2 km centroid to centroid distance (GOAL) (see 3.B.2.d)
Detector-Optics Ensquared energy (all bands)**		See 3.B.2.e and Tables 3c. and 3d. therein
Spatial coverage rate	1000 km x 1000 km region	Each 4.4 minutes, including any necessary allowance for IR calibration and navigation Operational scenarios may deviate from scanning a 1000x 1000 region, but this coverage rate is needed to provide both CONUS and a specified for sufficient mesoscale performance at high resolution
	Smaller and larger regions	Must be supported and selectable
Operation during eclipse*		Yes
Timeliness of data*	Radiance	3 minutes (threshold) and 1 minute (goal)
Simultaneity*		Within 10 sec. for all bands at any FOV (THRESHOLD); within 5 sec. (GOAL) (Limits cloud encroachment in FOV)
Pixel to pixel Simultaneity		Within 6 minutes for all adjacent pixels when covering 62 degree local zenith angle and within 3 minutes when covering a CONUS-sized area (THRESHOLD)
IR Spectral Bands and Spectral Resolution Radiometric Sensitivity Dynamic Range,		(Tables 4a, 4aa, 4b (rev), 6c. and 6d.)
Registration within frame (adjacent pixel)*		<= 0.5 IR IFOV at SSP (THRESHOLD); 0.25 IR IFOV at SSP (GOAL)
IR band linearity		See 3.B.2.j
Band to band co-registration	Visible-IR	<=1.0 km (<=28 urad
	IR-IR*	< 25% of IFOV (THRESHOLD) and < 10% of IFOV (GOAL)
On-orbit calibration	Visible	See 3.B.12
Lifetime***	Ground storage	5 years TBR
	On-orbit storage	5 years TBR is max possible
	Mean Mission Duration (MMD)	8.4 year (see section 3.B.1) TBR
	Instrument On Life	10 years at R=0.6 (see section 3.B.1)

*ID:*5671

Table 2d. HES CW Task Observational Requirements Parameters Summary (Partial List)

Requirement and Source		Threshold
Spatial resolution*	Reflected solar	0.3 km TBR on a centroid to centroid distance of 0.3 km (THRESHOLD) for wavelengths< 1.0 um and 1.2 km on a centroid distance of 1.2 km for wavelengths >/ = 1 um; 0.15 km on a centroid to centroid distance of 0.15 km (GOAL)
	IR (GOAL)	2.0 km TBR on a centroid to centroid distance of 2.0 km (THRESHOLD); 1.0 km on a centroid to centroid distance of 1.0 km (GOAL)
Modulation Transfer Function (all bands)		See 3.B.2.e and Tables 3f1, 3f2, and 3f3. therein
Spatial coverage rate	Coastal coverage along the length of the coast (US east and gulf coast: ~6000 km, US west coast ~2100 km) by ~400 km in width	Coastal coverage along length of coast (US east and gulf coast: ~6000 km (totaling ~ 2.4e6 km^2) in width in 3 hours (TBR)
	Regional and Mesoscale when required	Must be supported and selectable
Operation during eclipse*		Yes
Timeliness of data*	Radiance	15 minute (THRESHOLD), 5 minute (goal)
Simultaneity*		Within 15 sec. for all bands at any FOV (THRESHOLD); within 10 sec. (GOAL)
Pixel to pixel Simultaneity (threshold)		Within 10 minutes (TBR) for all adjacent pixels (THRESHOLD), TBD (GOAL)
IR Spectral bands and spectral resolution Radiometric Sensitivity Dynamic Range***		(Tables 4d and 6f.)
Registration within frame (adjacent pixels)		<= 1.0 IFOV at SSP (THRESHOLD) for 300 m max at SSP 0.83 IFOV at SSP (GOAL) for 250 m max at SSP
Reflected solar band linearity		See 3.B.2.j
Band to band co-registration	Within Reflected-solar region	<= 0.3 km (<= 9 mrad) at SSP (THRESHOLD); 0.25 km (7 mrad) at SSP (GOAL)
	Reflected solar -IR	For reflected solar < 1 um: <= 0.25 IR IFOV at SSP (THRESHOLD) or 0.3 km at SSP; <= 0.10 IFOV at SSP or 0.25 km at SSP (GOAL)
On-orbit calibration	Reflected solar	See 3.B.14
	IR	See 3.B.13
Lifetime***	Ground storage	5 years TBR
	On-orbit storage	5 years TBR is max possible
	Mean Mission Duration	8.4 years (see section 3.B.1) TBR

(MMD)	
Instrument On Life	10 years with R=0.6 (see section 3.B.1)

*ID:*5605

Table 2c. HES OO Task Observational Requirements Parameters Summary (Partial List)

Requirement and Source		Threshold
Spatial resolution*	Reflected solar	4.0 km TBR on a centric to centric distance of 4.0 km (THRESHOLD) 1.0 km on a centric to centric distance of 1.0 km (GOAL) (see 3.B.2.d)
Modulation Transfer Function (all bands)		See 3.B.2.e and Table 3.e. Therein
Spatial coverage rate	Open ocean area lying within the 62 degree LZA	Open ocean area lying within the 62 degree LZA in 3 hours (~6.8e7 km^2) (TBR)
	Regional and Mesoscale when required	Must be supported and selectable
Operation during eclipse*		Yes
Timeliness of data	Radiance	15 (TBR) minutes (THRESHOLD) (goal), 5 (TBR) minutes (GOAL)
Simultaneity*		Within 30 (TBR) sec. for all bands at any FOV (THRESHOLD); within 20 sec (GOAL)
Pixel to pixel Simultaneity		Within TBD minutes for all adjacent pixels (THRESHOLD)
IR Spectral bands and spectral resolution Radiometric Sensitivity Dynamic Range**		(Tables 4c and 6e.)
Registration within frame (adjacent pixels)		<= 0.5 IFOV (<= 56 urad at SSP (THRESHOLD); <= 0.25 IFOV (288 urad at SSP (GOAL)
Reflected solar band linearity		See 3.B.2.j
Band to band co-registration	Reflected solar	<= 0.5 IFOV at SSP (THRESHOLD) or 2.0 km at SSP; <= 0.25 IFOV at SSP or 1.0 km at SSP (GOAL);
On-orbit calibration	Reflected solar	(see 3.B.14)
Lifetime***	Ground storage	5 years TBR
	On-orbit storage	5 years TBR is max possible
	Mean Mission Duration (MMD)	8.4 year (see section 3.B.1) TBR
	Instrument On Life	10 years at R=0.6 (see section 3.B.1)

ID:
2194

(2.10.2) 3.B.1. Lifetime

ID:
2195
The instrument shall be designed for an 8.4 year Mean Mission Duration (MMD). A 10 year instrument-on life shall be supported with Reliability (R) of 0.6. The MMD is the integrated area under the instrument reliability versus time curve from t = 5 years to t = 15 years, divided by the reliability estimated at 5 years.

ID:
2196
Discussion: NOAA-NESDIS studied the benefits of extending the present lifetime of the current GOES series, as well as issues associated with extending the lifetime as a way to contain and reduce program costs. Given that new instruments are required to meet NWS requirements as well as provide replacements and new designs, it was timely to look at the longer life. However, long life may be traded against the insertion of new capabilities and/or technologies. Major long lifetime issues would be: Avoiding single point failure designs, long life evaluation through accelerated lifetime testing of selected components such as mechanisms, thermal control of optics and electronics, analyses such as FMECA (Failure Mode, Effects and Criticality Analysis). **

ID:
2197
Benefits: Extending the lifetime will save money by reducing program costs.

ID:
2198

(2.10.2) 3.B.2. Types of observations and accuracies

ID:
2199
The HES must yield spectral radiance observations suitable for retrieval of temperature and relative humidity over a three-dimensional set of reporting intervals defined below. The vertical observations will be retrieved from measured radiances over a two-dimensional grid defined as horizontal cells.

ID:
2200

(2.10.2) 3.B.2.a) Soundings

ID:
2201

These refer to retrieved profiles of atmospheric temperature and humidity as defined below. Note that it is not the intention of this document to specify sounding algorithms, but rather to specify radiometric performance determined in Phase-A studies to be sufficient to meet the observational requirements of Table 6a, Table 6aa, or 6b.

ID:
2202

(2.10.2) 3.B.2.b) Atmospheric Temperature Profile and Atmospheric Humidity Profile

ID:
2203
In the case of the temperature profile, this consists of a set of estimates of the average atmospheric temperature, in each of the sampling layers in NOAA's NWS specified vertical sampling scheme, in a three-dimensional volume (cell) centered on a specified point on a vertical line extending above a fixed longitude and latitude. The observational accuracy requirements given in Table 1 represent errors in a given layer. In the case of the atmospheric humidity profile, this consists of a set of estimates of the precipitable water, in each of the sampling layers in NOAA's NWS specified vertical sampling scheme, in a three-dimensional volume (cell) centered on a specified point on a vertical line extending above a fixed longitude and latitude. The observational accuracy requirements given in Table 1 represent errors in a given layer.

ID:
2204

(2.10.2) 3.B.2.c) Radiances

ID:
2205
Several national centers plan to use radiance information, however the radiance needs are currently consistent with the sounding requirements. The radiance values from the HES will be reported to the NOAA's NWS.

ID:
2206

(2.10.2) 3.B.2.d) Spatial Sampling

ID:
2207
This corresponds to the 2-dimensional horizontal ground sampling distance in km at nadir.

ID:
2208

For the DS task, the THRESHOLD spatial sampling of the IR bands shall be 10 km in both directions, measured at the satellite sub-point (SSP). The visible band shall have 1-km ground sample distance in both directions, measured at the satellite sub-point (SSP). The centroid-to-centroid distance between adjacent samples shall be no larger than the same dimension at SSP, eliminating gaps between samples. The GOAL spatial sampling should be 2 km in both directions for the IR bands and 0.5 km in both directions for the visible band(s), at the SSP. If finer spatial sampling is afforded, the instrument must be commandable to transmit samples with the threshold spatial sampling (within a small variation).

ID:
2209
For the SW/M task, the THRESHOLD spatial sampling of the IR bands shall be 4 km in both directions, measured at the satellite sub-point (SSP). The visible band shall have 1-km ground sample distance in both directions, measured at the satellite sub-point (SSP). The centroid-to-centroid distance between adjacent samples shall be no larger than the same dimension at SSP, eliminating gaps between samples. The GOAL spatial sampling should be 2 km in both directions for the IR bands and 0.5 km in both directions for the visible band(s), at the SSP.

ID:
2210
For the OO task, the THRESHOLD spatial sampling of the reflective solar bands shall be 4.0 km (TBR) in both directions, measured at the satellite sub-point (SSP). The centroid-to-centroid distance between adjacent samples shall be no larger than the same dimension at SSP, eliminating gaps between samples. The GOAL spatial sampling should be 1.0 km (TBR) in both directions for the reflective solar bands at the SSP. There is a longwave IR band that is often used for sea surface temperature; however, that coverage will be included in the ABI as well as the DS task of the HES but at reduced resolution.

ID:
2211
For the CW task, the THRESHOLD spatial sampling of the reflected solar bands shorter than 1 um shall be 0.3 km (TBR) in both directions, measured at the satellite sub-point (SSP). The THRESHOLD spatial sampling of the reflected solar bands longer than 1 um shall be 1.2 km (TBR) in both directions, measured at the satellite sub-point (SSP). The centroid-to-centroid distance between adjacent samples shall be no larger than the same dimensions at SSP, eliminating gaps between samples. The GOAL spatial sampling should be 0.15 km (TBR) in both directions for the reflected solar bands shorter than 1 um at the SSP. The GOAL spatial sampling should be 0.9 km (TBR) in both directions for the reflected solar bands longer than 1 um at the SSP. There is a longwave IR band that is often used for sea surface temperature; however, that coverage will be included in the ABI at reduced resolution. Since it does not appear likely that the resolution will be significantly better in the HES, this is a GOAL band to have it generated by the same instrument as the other CW tasks. The THRESHOLD resolution is 2.0 km for this GOAL band. The GOAL resolution is 1.0 km.
In the CW task, the HES-CW localized mode (under study) has a spatial resolution finer than 0.300 km that approach 0.150 km (TBR).
In the CW task, the "HES-CW localized mode 570" (under study) has a spatial resolution of 0.300 km (TBS).

ID:

2212

For all tasks, NOAA requires instrument-condition data to afford the best possible ground calibration.
Discussion: Algorithms employing the observational data and any necessary instrument-condition data for the ground-processing system will operate at near-real-time, as dictated by the instrument(s).

ID:
2213

Discussion: Because it is a goal for the DS task, the 4-km goal Ground Sampled Distance (GSD) is preferred over the 10 km THRESHOLD GSD. Because it is a goal for the SW/M task, the 2-km goal Ground Sampled Distance (GSD) is preferred over the 4-km THRESHOLD GSD.

ID:
2214

It is understood that the GSD in the DS task and in the SW/M task covering the mid-wave spectral region(s) (and hence the water vapor region) may be an improved spatial resolution compared to that for the longwave spectral region(s) or the shortwave spectral regions if present. The reason for this is that portions of the midwave band are used for moisture that varies spatially more than the temperature varies spatially. (The temperature near the surface also varies spatially but less variation is sensed at higher altitudes as observed along the CO_2 feature.) However, the ratio of the improved midwave sampling shall be chosen so that the ratio of the longwave GSD and shortwave GSD if present to the midwave GSD is an integer.

ID:
2215

Benefits: Increasing the spatial resolution greatly increases the likelihood of obtaining clear-air soundings, and improves the ability of HES to obtain soundings adjacent to cloudy regions. There is a need to perform sounding under all conditions including cloudy conditions. A microwave instrument is anticipated to fulfill this need but there may be retrievals performed above cloud tops using an IR sounder.

ID:
2216

Further Discussion: The spatial resolution of 10 km for the DS task corresponds approximately to that of the GOES I-M sounders, and is the coarsest acceptable spatial resolution of the HES. Because a sounding retrieval process is corrupted by the presence of cloud cover over even a portion of an IFOV (due to the high contrast in brightness temperature between clear and cloudy air), or by optical and focal plane effects, it is necessary to further refine the requirement for spatial resolution by specifying the detector-optics ensquared energy. This quantity specifies ensquared energy performance at the system level, with the phrase detector-optics used to emphasize the difference from the more typical usage of ensquared energy to refer to the optical performance only.

ID:
2217

(2.10.2) 3.B.2.e) Detector-Optics Ensquared Energy (DOEE) and Modulation Transfer Functions (MTFs) for the OO and CW tasks

ID:
2218
The DOEE is a unitless figure of merit, which is the ratio of the energy *detected by* a pixel from its corresponding single ground sample to the energy *detected by* this pixel from the entire large and uniform scene. A pixel is defined as an electro-optical system parameter comprising the radiance measurements in a rectangular area with dimensions on each side equal to the nadir ground sample distance (nominally 10 km or 4 km for the DS task, etc.). Scanning of the line of sight to cover the ground sample distance should be included. For a dispersive system, the DOEE applies only in the direction that is perpendicular to the slit, namely the non-dispersive direction. Also, see section (2.10.2) 3.B.20 on spectral purity for another constraint on spectral crosstalk. Detector-optics ensquared energy provides a measure of the rejection of out-of-field energy, addressing the diffraction spreading effects. As it is used here, the quantity does include focal plane crosstalk issues from adjacent detector samples. It is anticipated that appropriately small optical and electrical crosstalk should be achievable if measures are implemented such as reducing the detector fill-factor to optically isolate the FOVs, and/or by spatially tapering ("apodizing") the pupil illumination to reduce optical crosstalk arising from diffraction effects as well as diffusion effects. Without these measures, it is anticipated that the crosstalk will exceed the low levels of 2.5 percent from all neighbors used in determining the detector-optics ensquared energy values below.
Footnote: Based on Phase-A studies at MIT-Lincoln Laboratory.

ID:
2219
This quantity can be understood in terms of the scene-spread function, which is the convolution of the polychromatic system point-spread function (PSF) at the detector focal plane with the detector pixel geometry and signal spreading from the optics and the detector. Upon projecting (geometrically) this quantity to the earth scene, the relative response of the system as a function of location is obtained. The detector-optics ensquared energy is determined from measurement of the derivative of detector response to a knife-edge scanned across it and across its neighbors. The ratio of the signal from the geometric size of the central pixel to the signal from outside the geometric pixel size is the detector-optics ensquared energy.

ID:
2220
The ensquared energy varies with wavelength and can vary with pixel size. Table 3a. and Table 3b. show the threshold and goal ensquared energies in the DS task for an interferometric spectrometer and a dispersive spectrometer, respectively, at several wavelengths for both the 10 km x 10 km pixels and the 4 km x 4 km pixels. These wavelengths are not more important that other wavelengths but examples of the variation with wavelength. Table 3c and Table 3d show the threshold and goal ensquared energies in the SW/M task for the interferometric spectrometer and the dispersive spectrometer, respectively, at multiple wavelengths for the 10 km x 10 km pixels, the 4 km x 4 km pixels and the 2 km x 2 km pixels. The values for the 4 km pixel there are marked TBR since they are currently not consistent with the NEdN values listed in the Table 6c and 6d.

ID:
2221
Table 3e, Table 3f1, Table 3f2, Table 3f3 and Table 3g contain threshold requirements on MTF that shall be met to address similar specifications in the reflected solar spectral ranges for the OO, CW reflected solar <1 um region, CW reflected solar > 1 um region, and CW LWIR region, respectively. Table 3h contains the MTF requirements that shall be met for the visible channel for either the HES-DS task or the HES-SW/M task.

ID:
2222
Table 3a. The DOEE for an interferometric spectrometer performing the DS task

Detector-Optics Ensquared Energy for the interferometric spectrometer	13 um Threshold / Goal	6 um Threshold / Goal
For 10 x 10 km pixel (THRESHOLD pixel size)	90% / 93%	> or = 90% / > or = 93%
For 4 x 4 km pixel	> or = 64% / > or = 90%	> or = 64% / > or = 90%

ID:
2236
Table 3b. The DOEE for a dispersive spectrometer performing the DS task

Detector-Optics Ensquared Energy for the dispersive spectrometer	13 um Threshold / Goal	6 um Threshold / Goal	4.5 um Threshold / Goal	4 um Threshold / Goal
For 10 km spatial pixel (THRESHOLD pixel size)	90% / 93%	> or =90% / > or = 93%	> or = 90% / > or = 93%	> or = 90% / > or = 93%
For 4 km pixel	> or = 64% / > or =90%	> or = 64% / > or = 90%	> or = 64% / > or =90%	> or = 64% / > or = 90%

ID:
2256
Table 3c. The DOEE for an interferometric spectrometer performing the SW/M task

Detector-Optics Ensquared Energy for the interferometric spectrometer	13 um Threshold / Goal	6 um Threshold / Goal
For 10 x 10 km pixel (matches DS THRESHOLD pixel size)	90% / 93%	> or = 90% / > or =93%
For 4 x 4 km pixel (THRESHOLD pixel size)	> or = or =64% (TBR)/ 90%(TBR)	> or = 64% (TBR)/ > or = 90%(TBR)
For 2 x 2 km pixel (GOAL pixel size)	> or =90% (TBR)/ > or =93%(TBR)	> or =90% (TBR)/ > or =93%(TBR)

ID:
2274

Table 3d. The DOEE for a dispersive spectrometer performing the SW/M task

Detector-Optics Ensquared Energy for the dispersive spectrometer	13 um Threshold / Goal	6 um Threshold / Goal	4.5 um Threshold / Goal	4 um Threshold / Goal
For 10 km spatial pixel (matches DS threshold pixel size)	> or =90% / > or =93%	> or =90% / > or =93%	> or =90% / > or =93%	> or =90% / > or =93%
For 4 km pixel (THRESHOLD pixel size)	> or =64% (TBR)/ > or =90%(TBR)	> or =64% (TBR)/ > or =90%(TBR)	> or =64% (TBR)/ > or = 90%(TBR)	> or = 64% (TBR)/ > or = 90%(TBR)
For 2 km pixel (GOAL pixel size)	> or =90% (TBR)/ > or = 93%(TBR)	> or =90% (TBR)/ > or = 93%(TBR)	> or =90% (TBR)/ > or = 93%(TBR)	> or =90% (TBR)/ > or =93%(TBR)

ID:
2300
Table 3e. MTF for the instrument performing the OO task

Spatial Frequency		System MTF
(km/cyc)	(cyc/rad)	
32.0	1125	0.90 (TBR)
16.0	2250	0.73 (TBR)
10.66	3375	0.53 (TBR)
8.0	4500	0.32 (TBR)

ID:
2324
Table 3f1. The THRESHOLD MTF in the reflected solar < 1 um for the HES-CW.

Spatial Frequency		System MTF
(km/cyc)	(cyc/rad)	
2.4	15000	0.90 (TBR)
1.2	30000	0.73 (TBR)
0.8	45000	0.53 (TBR)
0.6	60000	0.32 (TBR)

ID:
2348
Table 3f2. The THRESHOLD MTF in the reflected solar > 1 um for the HES-CW

Spatial Frequency		System MTF
(km/cyc)	(cyc/rad)	
9.6	3750	0.90 (TBR)
4.8	7500	0.73 (TBR)
3.2	11250	0.53 (TBR)
2.4	15000	0.32 (TBR)

ID:
2372
Table 3f3. The THRESHOLD MTF in the LWIR for the HES-CW

Spatial Frequency		System MTF
(km/cyc)	(cyc/rad)	
16.0	2250	0.84
8.0	4500	0.62
5.33	6750	0.39
4.0	9000	0.22

ID:
2396
Table 3h. Visible band for HES-DS or HES-SW/M MTF

Spatial Frequency		System MTF
(km/cyc)	(cyc/rad)	
8.0	4500	0.85 (TBR)
4.0	9000	0.73 (TBR)
2.666	13500	0.53 (TBR)
2.0	18000	0.32 (TBR)

ID:
2420
Discussion: The retrieval of soundings through "holes" in cloud cover, and near the edge of cloud-covered regions, is corrupted by crosstalk between samples that causes cloud contamination to affect nominally cloud-free FOVs. During Phase-A concept design and technology studies, it was determined that meeting an 80% detector-optics ensquared energy for the DS task requirement would entail an aperture diameter of at least 25 cm, and that further improvement in detector-optics ensquared energy (>90% would be gained by additional measures such as reducing the detector fill-factor to optically isolate the FOVs, and/or by spatially tapering ("apodizing") the pupil illumination to reduce optical crosstalk arising from diffraction effects. It is expected that instrument performing the DS task may be less susceptible cloud corruption than the GOES I-M sounder if measures such as these are implemented.

ID:
2421

(2.10.2) 3.B.2.f) Horizontal Cell Size

ID:
2423

Horizontal cell size is a measure of the area (assumed square), which corresponds to either the reporting sample, for a retrieved sounding in the case of the DS or SW/M, or a reporting sample size in the case of the OO and CW tasks.

For all task, the THRESHOLD horizontal cell size is equivalent to the THRESHOLD spatial sampling size (see 3.B.2.d. above), measured at the SSP. For all task, the GOAL horizontal cell size is equivalent to the GOAL spatial sampling size (see 3.B.2.d. above), measured at the SSP.

Discussion: In the GOES-R timeframe, the horizontal cell size corresponds to the IFOV. The cell size may contain multiple sub-threshold IFOVs when averaging of several cells are used to reduce NEdN.

ID:
2424

(2.10.2) 3.B.2.g) Sensing Wavebands

ID:
2425

As noted in Section 2.A Instrument Description Assumptions, options exist for coverage of the spectrum to provide water vapor and temperature sounding information throughout the atmospheric regions of interest of the sounding tasks. Examples are given here for the spectral regions in which DS and SW/M observations can be obtained and processed to retrieval profiles for the DS and SW/M tasks. Also included here are the spectral regions of interest for the OO and CW observations that will be obtained and subsequently processed to obtain OO, or CW parameters. Meeting these spectral ranges and resolutions will be considered sufficient to provide the retrieval performance parameters noted earlier in this document. Other combinations of observation of the two CO_2 features, the ozone band, clear windows in the LWIR, volcanic ash near 8.5 um, and thin cirrus detection, and the water vapor feature in the midwave may also produce sufficient spectral coverage for the DS and SW/M tasks. The details of this are discussed more below. These comments also apply to the NEdN values listed in section (2.10.2) 3.B.2.n. The first paragraph below has general information about the spectroscopy involved. The second paragraph has information about an abstracted listing of spectral coverage. Further information can also be found about the DS and SW/M spectral coverage in the subsequent discussion section below the tables.

ID:
2426

In general, high spectral resolution permits the isolation of spectral information containing desirable sounding properties, such as sharp temperature or water vapor weighting functions in spectral intervals free from contamination by trace gas absorption. In addition it allows for very clear atmospheric windows. High spectral resolution also allows for many spectral observations containing redundant information about surface and atmospheric conditions, which can be utilized together to reduce the effective noise of the set of observations and further improve the accuracy of the soundings. Kaplan et al. (1977) show that it is desirable to be able to resolve spectral features in order to produce sharp temperature and moisture weighting functions in channels between the absorption lines. The main absorption features in the 15 um CO_2 band, which is used for temperature sounding, are roughly 1.5 cm^{-1} apart. Therefore, a spectral resolution of the order of 0.75 cm^{-1} would resolve these spectral features well. The most opaque feature of this band occurs at 667 cm^{-1}, with roughly equivalent atmospheric

information occurring in the spectral intervals +/-100 cm^{-1} from this center, providing information about temperature profile from 1 hPA to the surface. In the window regions covering 770 cm^{-1} to 1000 cm^{-1}, and 1070 cm^{-1} to 1200 cm^{-1}, a coarser spectral resolution ($\approx$ 1-2 cm^{-1}) is adequate to isolate the weak absorption lines; however, the first region contains lines that are important in determining cloud emissivity and cloud type so ~1 cm^{-1} or less (TBS) is more appropriate there. The intervening region between these two windows near 9.6 um (1040 cm^{-1}) contains absorption by many closely spaced O_3 lines. Information about the O_3 profile can be obtained even if these lines are not resolved. Because the ozone is used as a tracer, initially retrievals from the ozone feature will employ only a small number of levels. Water vapor profile information from the surface to 100 hPa is contained in the spectral interval 1200 cm^{-1} to 1600 cm^{-1}, and equivalent information is contained from 1600 cm^{-1} to 2000 cm^{-1}. A spectral resolution of the order of 1-2 cm^{-1} is sufficient to resolve these lines. Temperature sounding information is also contained in the spectral interval 2180 cm^{-1} - 2400 cm^{-1}. The spectral interval 2380 cm^{-1} to 2400 cm^{-1} is particularly significant for tropospheric temperature sounding. In this spectral region, a spectral resolution of 0.3 cm^{-1} is needed to resolve these lines, but important sounding information would be contained in channels in this interval even if the spectral resolution were 2.0 cm^{-1} (Kaplan et al., 1977). A window region exists from 2400 cm^{-1} to 2700 cm^{-1}. A spectral resolution of the order of 3 cm^{-1} is sufficient to isolate the weak absorption features here. Shortwave window channel observations, particularly in the most transparent channel at 2616 cm^{-1}, are also useful if they can be achieved with adequate signal to noise.

ID:
2427
The abbreviated spectral coverage requirements listed below have been abstracted from the examples listed below in Tables 4a, 4aa, and 4b. The first eight values together provide profile coverage of temperature information from the CO_2 feature near 15 um, clear window regions, coverage of the ozone feature neat 9.6 um, and detection of volcanic ash and thin cirrus. The next two points demonstrate water vapor coverage. The last three points provide shortwave coverage, which is helpful in determining tropospheric temperature, surface skin temperature, fire effects and cloud cover including fog. When multiple values are listed in the columns below, for consistency the user should select either 1) the first listing in each column for all columns, 2) the second listing for all columns or 3) the third listing for all columns. The complete listings of the example spectral coverage in Tables 4a, 4aa, and 4b and the corresponding NEdNs listed in Tables 6a, 6aa, and 6b may be helpful in any implementation because they are more detailed. The spectral resolution element listed in the table below is effectively the inverse of the maximum path difference. For the interferometric spectrometer, this is 1/(2L), where +L to -L is the maximum path difference. For the dispersive spectrometer, this is 1/(W(sin theta$_i$ + sin theta$_r$)) where W is the grating width, theta$_i$ is the angle of incidence, and theta$_r$ is the angle of reflection. The slight variation between the achieved resolution and the theoretical resolution is not critical here since the retrieval does not depend strongly on this level of variation. However, for reference the theoretical resolving power (out to the first zero, and 0.88 of half-maximum width) is R$_0$=lambda/(delta lambda) where lambda is the wavelength of interest and delta lambda is the spectral resolution element. The achieved resolving power is the quantity that is measured. The achieved resolving power is not only the convolution of the spectral feature with the dispersive/interferometric element function but also includes the convolution of the slit width. Thus the achieved resolving power (in terms of the half-maximum width) is R= R$_0$/u where u is the reduced slit width defined as the ratio of the exit slit width to the diffraction slit t width. Typical u is approximately 1.4, although it depends on the details of the system.

More background information is included in the discussion for this section following the multiple tables below.

Discussion: Note that alternate definitions of the resolution element for the types of instrument alter the size of the resolution element from the values listed below. This occurs in the HES PORD.

ID:
2428
Abstracted DS and SW/M task spectral coverage and resolution elements.

Wavenumber (cm^{-1})	Resolution element (cm^{-1})
650	0.625
670	0.625
700	0.625
750	0.625
800	0.625
950	0.625 or 0.75
1150	0.625 or 0.90
1200	0.625 or 0.94
1258 or 1923 or 1258	1.25 or 0.625 or 1.25
1650 or 1644 or 1650	1.25 or 0.625 or 1.25
2150 or 2141 or 2150	2.50 or 0.625 or 2.50
2350 or xx or 2350	2.50 or xx or < 2.50
2513 or xx or 2513	2.50 or xx or < 2.50

ID:
2472
As a goal, coverage of both sides of the water vapor feature (1200 - 1650 cm^{-1} and 1650 - 2150 cm^{-1}) should be provided.

ID:
2473
A dispersive spectrometer is usually specified in terms of wavelength rather than wavenumber. Thus, the waveband sampling for dispersive spectrometer in the DS and SW/M tasks is specified in a separate table, which lists the resolution in wavelength and wavenumber. Examples 1 and 2 in Tables 4a and 4aa are listed in wavenumber while example 3 in Table 4b is listed in wavelength.

ID:
2474
For the dispersive spectrometer(s) performing the DS task and the SW/M task, the wavebands listed below can be covered, but several dispersive elements may cover an IR band. Thus, the narrower spectral range covered by a dispersive spectrometer will be called a spectral region, rather than a spectral band.

ID:
2475

For the OO task, the threshold and goal bands are listed in Table 4c. The threshold bands and applications are listed here. The goal channels provide all channels in the range to accommodate more products. The bands listed here are combination of common ocean bands. ***

ID:
2476

OO Task Spectral Bands

Wavelength (um)	Application
0.4 -1.0 um continuous or all of the bands listed below (GOAL)	All of below plus additional
0.412 (GOAL)	Dissolved organic carbon
0.443 (THRESHOLD)	Chlorophyll a absorbance, yellow substances
0.477 (GOAL)	Fluorescence Chlorophyll a, Absorption Chlorophyll b, O_2:O_2 dimmer
0.490 (THRESHOLD)	Water depth (from reflection by sea grass, absorption by pigments), Chlorophyll a (empirical)
0.510 (GOAL)	Accessory Pigments
0.530 (THRESHOLD)	Suspended sediment
0.550 (THRESHOLD)	Chlorophyll a Baseline, backscatter sediments
0.645 (THRESHOLD)	Vegetation (MODIS)
0.667 (THRESHOLD)	Chlorophyll a absorption, Vegetation, Fluorescence, coccolith concentration
0.678 (GOAL)	Fluorescence, Vegetation
0.750 (GOAL)	Atmospheric correction (cloud reflectance), Vegetation
0.763 (GOAL)	O_2 A band
0.865 (THRESHOLD)	Vegetation reflection, Atmospheric correction, atmospheric suspended solids, Fluorescence Chlorophyll c (red algae), suspended organic solids
0.905 (GOAL)	Column water

ID:
2526

CW Task Spectral Bands

For the CW task, the threshold and goal bands are listed in Table 4d. The threshold bands and applications are listed here. The goal channels provide all channels in the range to accommodate more products.

Wavelength (um)	Application
0.4 - 1.0 um centered at 0.667 um (GOAL) or 0.4 - 2.285 um centered at 0.667 um (additional GOAL)	All of the applications below for lambda less than 1.0 um (or 2.285 um) and the ability to form additional bands for new applications

0.412 (THRESHOLD)	Dissolved organic carbon
0.443 (THRESHOLD)	Chlorophyll a absorbance, yellow substances
0.477 (THRESHOLD)	Fluorescence Chlorophyll a, Absorption Chlorophyll b, O_2:O_2 dimmer
0.490 (THRESHOLD)	Water depth (from reflection by sea grass, absorption by pigments), Chlorophyll a (empirical)
0.510 (THRESHOLD)	Accessory Pigments
0.530 (THRESHOLD)	Suspended sediment
0.550 (THRESHOLD)	Chlorophyll a Baseline, backscatter sediments
0.645 (THRESHOLD	Vegetation (MODIS)
0.667 (THRESHOLD)	Chlorophyll a absorption, Vegetation, Fluorescence, coccolith concentration
0.678 (THRESHOLD)	Fluorescence, Vegetation
0.750 (THRESHOLD)	Atmospheric correction (cloud reflectance), Vegetation
0.763 (THRESHOLD)	O_2 A band
0.865 (THRESHOLD)	Vegetation reflection, Atmospheric correction, atmospheric suspended solids, Fluorescence Chlorophyll c (red algae), suspended organic solids
0.905 (THRESHOLD)	Column water
1.38 (GOAL)	Daytime cirrus cloud
1.61 (GOAL)	Daytime cloud water
2.26 (GOAL)	Daytime cloud properties
11.2 (GOAL)	Total water for Sea Surface Temperature (SST)
12.3 (GOAL)	Sea Surface Temperature (SST)

ID:
5867

0.570 (Under study)	Light Use Efficiency (with 0.530 um) for carbon cycle

ID:
2591
Table 4a. Interferometric Sounder Waveband Descriptions Example 1 for DS and/or SW/M tasks (similar to GIFTS bands; see following discussion). A visible band is also required.

Waveband (cm^{-1})	Wavelength (um)	Spectral bin size (cm^{-1})	Number of bins (1840)
650 - 1200	15.38 - 8.33	0.625	880
1650 - 2250	6.06 - 4.44	0.625	960

ID:
2608
Table 4aa. Interferometric Sounder Waveband Descriptions Example 2 for DS and/or SW/M tasks (similar to CrIS bands; see following discussion). A visible band is also required.

Waveband (cm^{-1})	Wavelength	Spectral bin size (cm^{-1})	Number of

	(um)			bins (1532)
650 - 1200	15.38 - 8.33	0.625		880
1210 - 1740	8.26 - 5.74	1.25		424
2150 - 2720	4.65 - 3.68	2.5		228

ID:
2630
Table 4b. Dispersive Sounder Waveband Descriptions Example for DS and/or SW/M tasks (grating type, but not AIRS specifically; see following discussion). A visible band is also required.

Wavelength (um)	Wavenumber (cm^{-1})	Bin size (um)	Bin size (cm^{-1})	Number of bins (~1800)
15.38 -10.54	650 - 950	< or = 0.01um at 12.54 um	0.625 cm^{-1} at the shortwave side of all spectral regions	~600
10.54 -6.25	950 -1600	< or =0.008 um at 8.1 um, < or =0.006 at 6.8 um	1.25 cm^{-1} at the shortwave side of all spectral regions	~600
4.8 - 4.25	2100 - 2350	< or = 0.0023 um at 4.25 um	1.25 cm^{-1} at the shortwave side of all spectral regions	~300
4.25 - 3.85	2351 - 2600	< or = 0.0018 um at 3.85 um	1.25 cm^{-1} at the shortwave side of all spectral regions	~350

ID:
2662
Table 4c. OO Task Band Descriptions (Thresholds and Goals)

Wavelength (um)	Bin size (um)	Number of bins
0.4 -1.0 um (GOAL), centered at 0.667 (thus 0.407 - 0.987)	0.02 (T), 0.01 (G)	35 (T), 58 (G)
0.412	0.02 (T), 0.01 (G)	1
0.443 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.477 (GOAL)	0.02 (T), 0.01 (G)	1
0.490 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.510 (GOAL)	0.02 (T), 0.01 (G)	1
0.530 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.550 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.645 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.667 (THRESHOLD)	0.01	1
0.678 (GOAL)	0.01	1
0.750 (GOAL)	0.02 (T), 0.01 (G)	1
0.763 (GOAL)	0.02 (T), 0.01 (G)	1
0.865 (THRESHOLD)	0.02 (T), 0.01 (G)	1

| 0.905 (GOAL) | 0.02 (T), 0.01 (G) | 1 |

Table 4d. CW Task Band Descriptions (Thresholds and Goals)

Wavelength (um)	Bin size (um)	Number of bins
0.4 - 1.0 um centered at 0.667 um (GOAL) or 0.4 - 2.285 um centered at 0.667 um (additional GOAL)	0.02, 0.8, 1.0	97
0.412 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.443 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.477 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.490 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.510 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.530 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.550 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.645 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.667 (THRESHOLD)	0.01	1
0.678 (THRESHOLD)	0.01	1
0.750 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.763 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.865 (THRESHOLD)	0.02 (T), 0.01 (G)	1
0.905 (THRESHOLD)	0.035	1
1.38 (GOAL)	0.03	1
1.61 (GOAL)	0.06	1
2.26 (GOAL)	0.05	1
11.2 (GOAL)	0.8	1
12.3 (GOAL)	1.0	1

| 0.570 (Under study) | 0.01 | 1 |

Discussion: The wavebands in Tables 4a and 4b have been selected for the DS task and the SW/M task based on their utility in producing the desired sounding retrievals, but see comments in this section above. (Of course, for a fuller range of applications, the entire infrared spectra would be ideal.)

In developing the wave band examples for the interferometer(s) performing the DS task and the SW/M task, the smallest wavenumber (longest wavelength) band was extended from 650-1150 to 650-1200 to

include information near 8.5 um. This extension on the shortwave side of the longwave band has kept the interferometric example 1 above from being an exact match to that of CrIS.

ID:
2816
In terms of modeled retrieval performance, the Cooperative Institute for Meteorological Satellite Studies (CIMSS) has shown comparable performance between a Geosynchronous Interferometric Sounder (GIFTS)-like 2 waveband interferometer system (described above as interferometric example 1) and a Cross-track Interferometric Sounder (CrIS)-like 3 waveband interferometer system (with large photovoltaic FPAs) under clear conditions based on noise inputs from MIT-LL and from the GIFTS team (described above as interferometric example 2) (GIFTS will fly on the Earth Observing (EO)-3 as part of NASA's New Millennium Program). AIRS is a flying example of a grating for sounding. AIRS is a multi-detector array grating spectrometer with a roughly constant resolving power $\nu/\Delta\nu \approx 1300$, and essentially contiguous spectral coverage from 650 cm^{-1} - 1620 cm^{-1} $\left(\Delta\nu \approx 0.5 \text{ cm}^{-1} - 1.2 \text{ cm}^{-1}\right)$ and 2170 cm^{-1} - 2700 cm^{-1} $\left(\Delta\nu \approx 1.7 \text{ cm}^{-1} - 2.1 \text{ cm}^{-1}\right)$ with spectral sampling of 2 channels per $\Delta\nu$. Each channel has its own detector, with channel noise $\left(\text{NE}\Delta\text{T at } 250\text{K}\right)$ on the order of 0.1K - 0.2K for the smallest values. The predicted noise for $\left(\text{NE}\Delta\text{T at } 250\text{K}\right)$ for CrIS is on the order of 0.1K - 0.2K per channel for the smallest values. Thus, the NEdT performance of these instruments is generally the same.

ID:
2817
MIT-LL has done phase A studies for NOAA investigating how to reduce the variation in radiance reflectance that occurs at varying scan angles at certain wavelengths near 8 microns with SiOx mirror coatings used on the current GOES I-M imager and sounder instruments.

ID:
2818
The examples of wavebands for the dispersive spectrometer (s) performing the DS task and the SW/M task has been generalized from those developed in a point design performed for NOAA/NESDIS by MIT Lincoln Laboratory. Ultimately the spectral coverage for the DS and the SW/M tasks is derived from the detailed study of the interferometer retrieval performance for GOES and has been partially optimized for a grating through a detailed discussion with Allen Huang at UW. AIRS is a flying example of a grating for sounding. As part of latest point design study, the specific results were used to further validate the wavebands through retrievals.

ID:
2819
Coverage of these spectral regions near the listed resolution is currently considered sufficient for the DS and SW/M tasks. A more extensive optimization study of the necessary and sufficient wavelength coverage for each wavelength for the DS and the SW/M tasks has been considered by the government team but has not yet begun.

ID:
2820

It is anticipated that the spectral regions for the dispersive system for the DS and the SW/M tasks will have further subdivisions to optimize the instrument. For this reason, the wavelength resolution requirements are not detailed more fully than they are in the table. For the dispersive system for the DS and SW/M tasks, the required spectral coverage does differ from that of the interferometer and the required resolution is actually degraded compared to the two-band interferometer.

ID:
2821
The band listings for each of the OO and CW tasks reflect understanding of current algorithms used to obtain the products listed in the GPRD-1.

ID:
2822

(2.10.2) 3.B.2.h) Detailed Discussion of Wavebands for the DS task and the SW/M task

ID:
2823
1) Interferometric Spectrometer: There is no unique set of wavenumbers for an interferometer. The radiance spectrum obtained from the cosine transform of the sampled interferogram is continuous and well defined at all wavenumbers in the band.

ID:
2824
2) Dispersive Spectrometer: There is no unique set of wavelengths for a dispersive spectrometer in general; however, the wavelengths required for the retrievals must be covered by the spectral regions employed in the observations.

ID:
2825
Number of wavenumber channels for the DS task and the SW/M task:

ID:
2826
Interferometric Spectrometer: A fast Fourier transform (FFT) of a sampled interferogram provides a set of spectral radiances uniformly spaced by the wavenumber step size across the band.

ID:
2827
Dispersive Spectrometer: The dispersive spectrometer provides a set of uniformly spaced samples, in wavelength, of spectral radiance across the spectral region of interest.

ID:
2828
Aliasing for the DS task and the SW/M task:

ID:
2829
Interferometric Spectrometer: The interferometric signal shall be appropriately sampled to minimize aliasing and moving mirror velocity fluctuation errors.

ID:
2830
Dispersive Spectrometer: The spectrometer will not experience the same noise terms as the interferometric spectrometer. The signal level of any interference from other orders (ghosts) should be small compared to the NEdN.

ID:
2831
Wavenumber step size for the DS task and the SW/M task:

ID:
2832
Interferometric Spectrometer: The wavenumber bin size (dv) between spectral data points is defined as the reciprocal of the optical path difference (OPD) between the first and last samples of the sampled interferogram. The wavenumber step size will vary with off-axis field angle and each detector FOV must be appropriately compensated.

ID:
2833
Dispersive Spectrometer: The wavelength bin size is defined by the resolution in Table 4b.

ID:
2834
Unapodized spectral resolution for the DS task and the SW/M task:

ID:
2835
1)   Interferometric Spectrometer: The unapodized spectral resolution is defined as the reciprocal of twice the maximum optical path difference from zero path difference (ZPD), i.e. if the maximum OPD change is L, the wavenumber step size is $1/2L$.

ID:
2836
2)   Dispersive Spectrometer: The wavelength step size is defined by the resolution in Table 4b.

ID:
2837
Retrieval spectral channel wavenumbers for the DS task and the SW/M task:

ID:

2838
Interferometric Spectrometer: The on-axis set of nominal retrieval spectral channel wavenumbers shall be provided. (see 3.B.20 and comments in section 3.B.2.g on sensing wavebands.)

ID:
2839
Dispersive Spectrometer: The nominal retrieval spectral channel wavelengths shall be provided. (see 3.B.20)

ID:
2840

(2.10.2) 3.B.2.i) Dynamic Range

ID:
2841
The dynamic range for each band containing wavelengths longer than 3 um associated with the DS task and/or the SW/M task shall be sufficient to span the range from the brightness temperature corresponding to the space background to the temperature of the blackbody calibration target, or the highest scene temperature (whichever is larger). This is also intended to prevent saturation (high or low counts) over the life of the instrument and under worse case conditions for the bands containing wavelengths longer than 3 um.

ID:
2842
The dynamic range for each band associated with the OO task shall be sufficient to span the incoming signal range from 0% to 1.1 times the scene signal radiance (TBS), where the radiance levels are located in the radiance appendix. The scene radiance does not include cloud radiances however, the cloud radiances must be measured in each band. A pixel that is located five (TBR) or more pixels away from a saturated cloud edge shall meet the performance specifications and a pixel located more than 3 (TBR) pixels away and less than five (TBR) away should have a signal to noise ratio of no less than one half of the signal to noise. Sun glint is may saturate the pixel; however, a pixel that is located five (Threshold) more pixels away or three (Goal) or more pixels away from a cloud edge shall meet the performance specifications.

To meet these requirements, a full characterization is required for the effects of stray light due to unwanted background signals from high signal levels in the instrument. The spatial variations of the stray light depend on the spatial variations of the cloud cover conditions which can vary by waveband and thus must be characterized.

ID:
2843
The dynamic range for each band associated with the CW task shall be sufficient to span the incoming signal range from 0% to 1.1 times the scene signal radiance (TBS), where the radiance levels are located in the radiance appendix. The scene radiance does not include cloud radiances; however, the cloud radiances must be measured in each band. A pixel that is located five (TBR) or more pixels away from a

saturated cloud edge shall meet the performance specifications and a pixel located more than 3 (TBR) pixels away and less than five (TBR) away should have a signal to noise ratio of no less than one half of the signal to noise. Sun glint is may saturate the pixel; however, a pixel that is located five (Threshold) more pixels away or three (goal) or more pixels away from a cloud edge shall meet the performance specifications.

To meet these requirements, a full characterization is required for the effects of stray light due to unwanted background signals from high signal levels in the instrument. The spatial variations of the stray light depend on the spatial variations of the cloud cover conditions that can vary by waveband and thus must be characterized.

ID:
2844

(2.10.2) 3.B.2.j) System Linearity

ID:
2845
The corrected system response nonlinearity across the instruments' dynamic range for each task shall be measured and demonstrated to be stable enough to meet radiometric performance, and shall be provided to the government.

ID:
2846

(2.10.2) 3.B.2.k) Removed

ID:
2847

(2.10.2) 3.B.2.l) Noise-Equivalent Temperature Difference (NEDT) and Noise-Equivalent Radiance Difference (NEdN) for the DS task and the SW/M task

ID:
2848
The noise performance requirements are defined at the aperture of the system by the noise-equivalent radiance difference (NEdN) arriving from the top of the atmosphere (TOA). The NEdT at a given wavenumber or wavelength is defined by dividing the NEdN at that wavenumber or wavelength by the derivative with respect to temperature of the Planck blackbody radiance function, evaluated at 250 K at the same wavenumber or wavelength.

ID:
2849

(2.10.2) 3.B.2.m) Earth Scene Variation

ID:
2850
The noise performance of the instrument will depend on the earth scene. The earth scenes plotted in Figures 2 through 3 are representative of the extremes in earth radiance.

ID:
2851
Interferometric Spectrometer for the DS task and/or the SW/M task: The interferometer noise will depend on the broadband integrated flux. The blackbody temperatures for equivalent in-band scenes' radiance are given in Table 5a. The radiance levels from blackbodies of these temperatures are plotted in Figures 2a and 2b along with the earth scene radiances that they simulate. From Figures 2a and 2b, blackbody temperatures listed in Table 5.a. are sufficient to produce integrated flux levels representative of the highest and lowest integrated flux expected in each band (see section 3.B.2.g for discussion of wavebands) for the interferometric instrument performing the DS task and/or the SW/M task for the HES instrument on-orbit.

ID:
2852
Dispersive Spectrometer for the DS task and/or the SW/M task: The dispersive spectrometer noise performance will depend on the flux in the resolution element. The simulated, cloud-free earth scene radiances over the entire 3.84 - 15.4 um region for hot, nominal, and cool scenes are shown in Table 5b (in the radiance appendix document) for a dispersive spectrometer HES on orbit. (See section 3.B.2.g. for discussion of wavebands) Because the spectral regions may be subdivided for the dispersive spectrometer, it would be misleading to provide the maximum blackbody temperature in each spectral region. However, Figure 3 shows the blackbody temperature of the maximum feature along with the reference radiances for on orbit.

ID:
2853
Table 5a. Blackbody temperatures for equivalent in-band scene radiances for interferometer performing the DS task and/or the SW/M task

	Hot (K)	Nominal (K)	Cool (K)
Band 1: 650 - 1200 cm^{-1}	290	267	234
Band 2: 1650 - 2250 cm-1	271	251	235

ID:
2871
Table 5b. Earth-scene radiances for dispersive spectrometer (See separate Appendix Document.)

ID:
6333
<Picture>

HOT, MODERATE, AND COOL EARTH SCENE
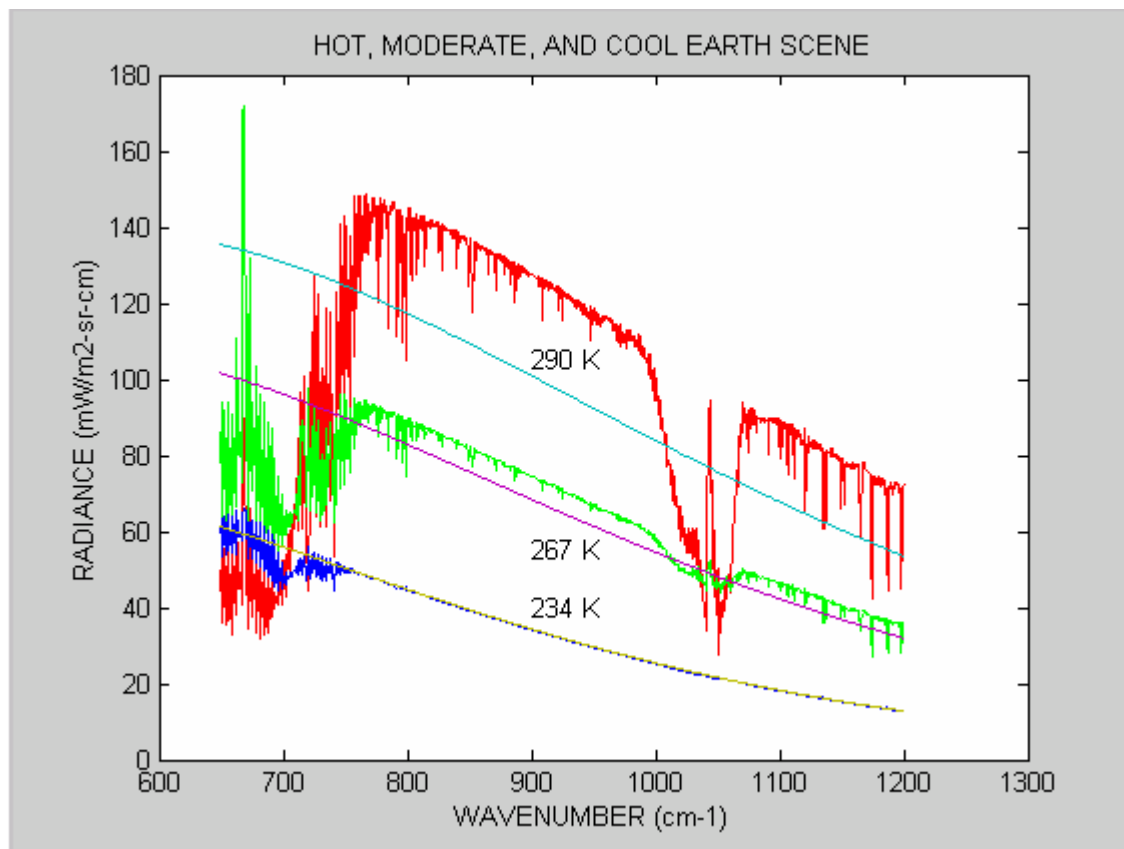
ID:
2873
Figure 2a. Three earth radiance profiles for 650 to 1200 cm^{-1}. The blackbody temperatures that produce the equivalent in-band radiance for the interferometric spectrometer performing the DS task and/or the SW/M task are shown for hot, nominal, and cool scenes.

ID:
6334
<Picture>

HOT, MODERATE, AND COOL EARTH SCENE
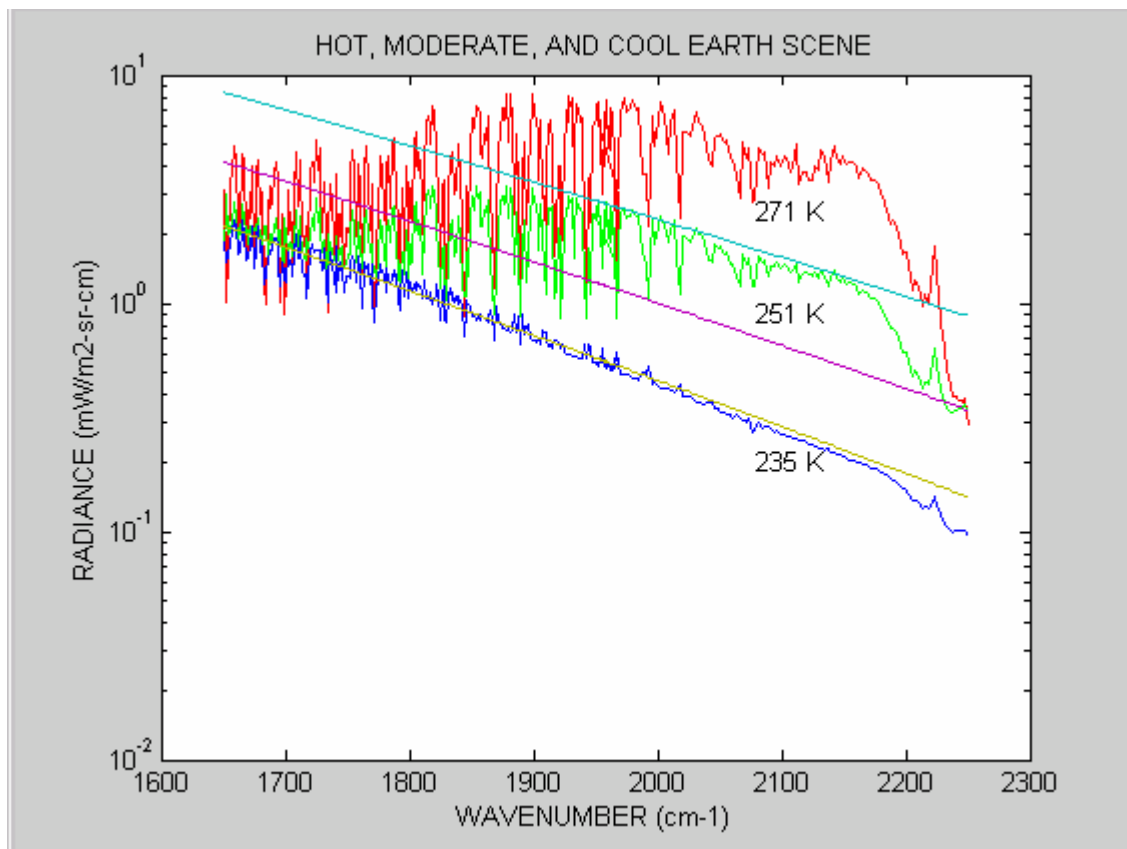
ID:
2875
Figure 2b. Three earth radiance profiles for the 1650 to 2250 cm^{-1}. The blackbody temperatures that produce the equivalent in-band radiance for the interferometric spectrometer performing the DS task and/or the SW/M task are shown for hot, nominal, and cool scenes.

ID:
6337
<Picture>
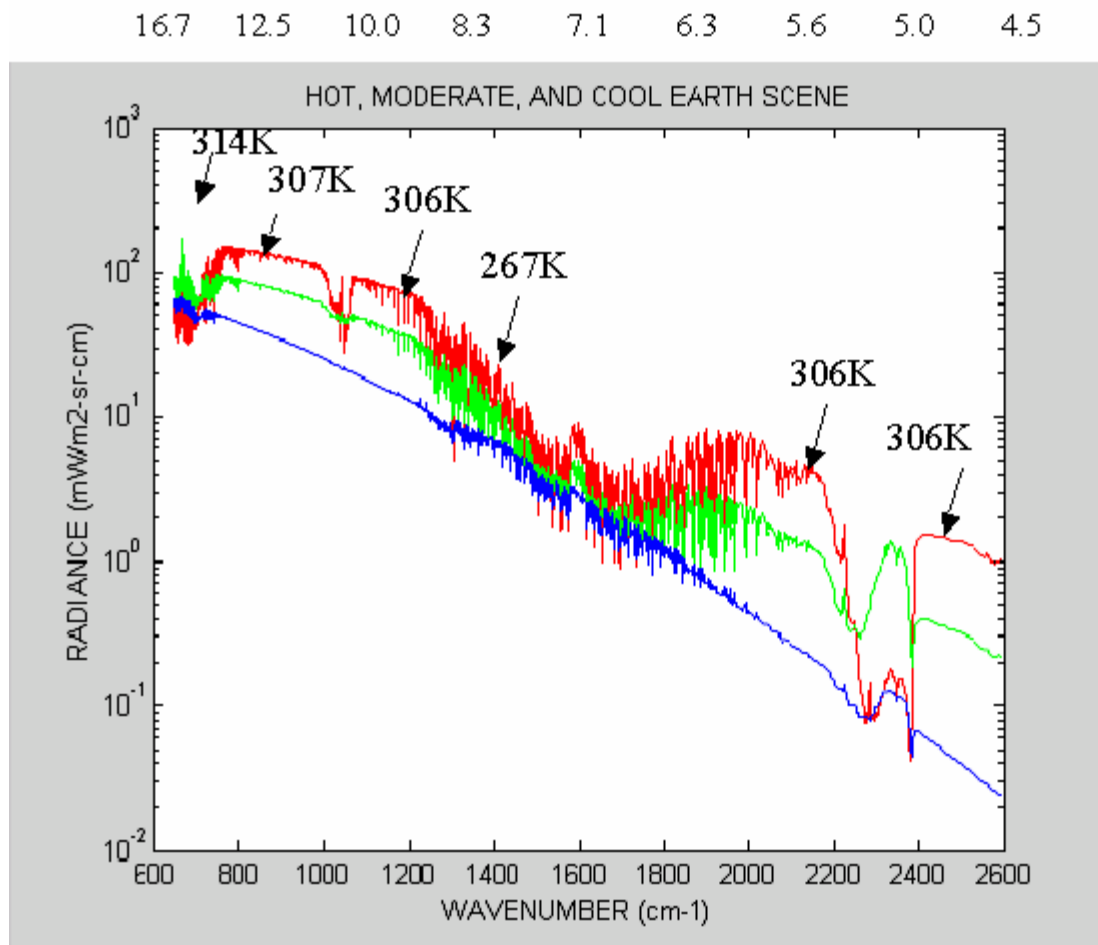
ID:
2876
Figure 3. Three earth radiance profiles for the dispersive spectrometer performing the DS task and/or the SW/M task are shown for hot, nominal, and cool earth scenes. The blackbody temperatures for the maximum earth scene radiances are shown at various wavenumbers/wavelengths in the figure. The radiances are provided in Table 5b (in the appendix document).

ID:
2877

(2.10.2) 3.B.2.n) Noise Radiance Performance and Signal to Noise

ID:
2878
Under normal operating conditions, the portion of the HES performing the DS task shall be designed to be consistent with the abstracted listing below in the following unnumbered table. See Section (2.10.2) 3.B.2.g for comments on the spectral coverage. In this way the instrument performing this task will

provide data consistent with the observational accuracy requirements in Table 1. The abstracted listing is an abbreviated listing that is consistent with the noise performance listed in Table 6a and/or Table 6aa for the interferometric spectrometer and Table 6b for the dispersive spectrometer.

ID:
2879
Table 6a, Table 6aa, and Table 6b reflect both example design studies and retrieval performance studies performed in Phase-A. The example designs cover varied spectral regions. They indicate the maximum allowed noise equivalent radiance error (NEdN) values considered sufficient to meet NOAA's NWS observational requirements under normal operating conditions in clear air in the DS task. These values reflect the need to have similar noise characterizes from the polar-orbiting systems (i.e., CrIS) and the geostationary sounders to obtain the needed retrieval performance in Table 1, including some risk reduction assessments to afford improved spacecraft accommodation.
Again, this represents an example design whose noise performance values produce retrievals meeting NOAA's NWS needs. Meeting these NEdN values, and in particular meeting the requirement of the abstracted NEdN values in the table just below implies sufficient retrieval performance. The system should be flexible in order to permit an increase in the effective dwell time (or rapid repeated data acquisitions over a fixed region) in order to increase the signal-to-noise ratio for selected scans.

ID:
2880
As discussed above, abstracting the NEdN values in Tables 6a, 6aa, and 6b for the DS task yields the abbreviated list below. When multiple values are listed in the columns below, for consistency the user should select one of the following: 1) the first listing in each column for all columns, 2) the second listing for all columns 3) the third listing for all columns. The complete listings of the example NEdN's in Table 6a, 6aa, and 6b will be helpful in any implementation because they are more detailed. The abstracted NEdN's as well as the example listings are plotted in Figure 4. These listings reflect threshold levels. In order to meet all of the points in a spectral band, it may be necessary to achieve NEdN values that are lower than the abstracted NEdN listing. One such point is listed in the abstracted NEdN table below in parenthesis and is only shown to be consistent with the figure below.

ID:
2881
Goal levels are the first and third set of numbers in each of the four columns below and lower noise numbers in any location, particularly the IR. These reflect a lower level of noise performance in the SWIR that should afford better retrieval performance in the presence of clouds. This lower level of noise in the SWIR as a goal is 1/3 of the listed NEdN values.

Wavenumber (cm^{-1})	Resolution element	NEdN $(mW/m^2\ sr\ cm\text{-}1)$	NEdT at 250 K (K)
650	0.625	$</=1.265$	$</=1.036$
670	0.625	$</=0.40$	$</=0.31$
700	0.625	$</=0.212$	$</=0.175$
750	0.625	$</=0.176$	$</=0.147$
800	0.625	$</=0.166$	$</=0.146$
950	0.625	$</=0.182$	$</=0.191$

1150	0.625	$</=0.310$	$</=0.483$
1200	0.625	$</=0.529$	$</=0.918$ (goal)
1258 or 1923 or 1258	1.25 or 0.625 or 1.25	$</=0.066$ or $</=0.050$ or $</=0.066$	$</=0.135$ or $</=0.853$ or <0.135
1650 or 1644 or 1650	1.25 or 0.625 or (1.25)	$</=0.092$ or $</=0.077$ or <0.092 (using 0.05 for the third column meets all point across the band, as shown in Fig. 4)	$</=0.605$ or $</=0.504$ or <0.605 (using 0.33 for the third column meets all points across the band, as shown in Fig.4)
2150 or 2141 or 2150	2.50 or 0.625 or 2.50	$</=0.01$ or $</=0.061$ or <0.01	$</=0.416$ or $</=2.383$ or <0.416
2350 or xx or 2350	2.50 or xx or <2.50	$</=0.011$ or xx or <0.01	$</=0.966$ or xx or $</=0.966$
2513 or xx or 2513	2.50 or xx or <2.50	$</=0.011$ or xx or <0.011	$</=1.981$ or xx or <1.981

ID:
2953
The same parameters are listed for the portion of the HES performing the SW/M task in Table 6c and Table 6d. Although an abstracted listing is not specifically listed for this task, it would be functionally identical to the abstracted NEdN listing for the DS task above. Table 6e lists the signal to noise required for the OO task. Table 6f lists the signal to noise for the CW task. Typical ocean radiances are less than 100 W/m^2/um/sr.

ID:
6338
<Picture>

NEdNs for HES-DS when using examples 1, 2, and 3 from the MRD
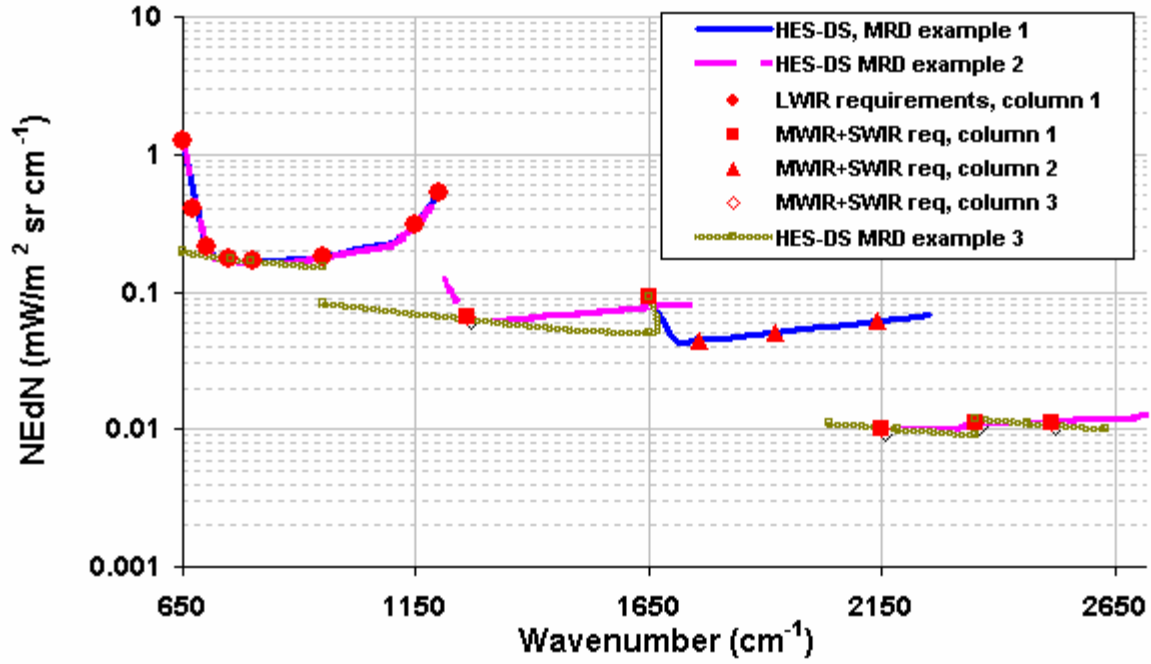
ID:
2954
Figure 4. Plot of abstracted NEDN listing (symbols) and example NEdN values (lines) for examples 1, 2, and 3 of the HES-DS task.

ID:
2955
Table 6a. Example 1 maximum allowed NEdN for the DS task interferometric example at the Hot Test Target Temperature listed in Table 5a. (For reference, this set of NEdT's evaluated at 250 K has been included. For reference, the bin size has been listed here from the relevant portion of table 4).

Wavenumber (cm^{-1})	Bin size (cm$^{-1)}$	Max. NEdN [mW/(m^2 sr cm^{-1})]	(Corresponding NEdT values at 250 K for reference)
650.00000	0.625	1.265	(1.036)
700.00000	0.625	0.212	(0.175)

750.00000	0.625	0.176	(0.147)
800.00000	0.625	0.166	(0.146)
850.00000	0.625	0.166	(0.152)
900.00000	0.625	0.171	(0.168)
950.00000	0.625	0.182	(0.191)
1000.00000	0.625	0.195	(0.223)
1050.00000	0.625	0.210	(0.264)
1100.00000	0.625	0.225	(0.313)
1150.00000	0.625	0.310	(0.483)
1200.00000	0.625	0.529	(0.918)
1650.00000	0.625	0.092	(0.605)
1705.00000	0.625	0.044	(0.346)
1759.00000	0.625	0.045	(0.429)
1814.00000	0.625	0.046	(0.529)
1868.00000	0.625	0.048	(0.670)
1923.00000	0.625	0.050	(0.853)
1977.00000	0.625	0.053	(1.106)
2032.00000	0.625	0.055	(1.413)
2086.00000	0.625	0.058	(1.829)
2141.00000	0.625	0.061	(2.383)
2195.00000	0.625	0.064	(2.310)
2250.00000	0.625	0.067	(4.012)

ID:
3082

Table 6aa. Example 2 maximum allowed NEdN for the DS task interferometric example at the Hot Test Target Temperature listed in Table 5a. For reference, the bin size has been listed from table 4.

Wavenumber (cm^{-1})	Bin size (cm^{-1})	NEdN [mW/(m^2 sr cm^{-1})]	Corresponding NEdT values at 250 K for reference (K)
650	0.625	1.155	0.948
670	0.625	0.405	0.332
700	0.625	0.208	0.171
750	0.625	0.173	0.145
800	0.625	0.163	0.142
850	0.625	0.163	0.149
900	0.625	0.169	0.165
950	0.625	0.179	0.187
1000	0.625	0.192	0.217
1050	0.625	0.207	0.257
1100	0.625	0.221	0.305
1150	0.625	0.296	0.361

1200	0.625	0.52	0.913
1210	1.25	0.12	0.215
1258	1.25	0.066	0.135
1306	1.25	0.062	0.143
1355	1.25	0.064	0.168
1403	1.25	0.066	0.196
1451	1.25	0.068	0.234
1499	1.25	0.07	0.285
1547	1.25	0.072	0.345
1595	1.25	0.075	0.425
1644	1.25	0.077	0.519
1692	1.25	0.08	0.601
1740	1.25	0.083	0.736
2150	2.25	0.01	0.416
2202	2.25	0.01	0.507
2254	2.25	0.01	0.594
2306	2.25	0.01	0.750
2358	2.25	0.011	0.919
2410	2.25	0.011	1.124
2461	2.25	0.011	1.457
2513	2.25	0.011	1.981
2565	2.25	0.012	2.607
2617	2.25	0.012	3.324
2669	2.25	0.012	4.241
2721	2.25	0.012	5.407

ID:
3274

Table 6b. Maximum allowed NEdN for the DS task dispersive example at listed Test Target Temperatures. For reference, the bin size has been listed from Table 4.

Wavelength (um)	Wave-number (cm^{-1})	Bin size (um)	Bin size (cm^{-1})	Max. NEdN $[mW/(m^2 sr cm^{-1})]$	Corresponding NEdT values at 250 K for reference (K)
15.38-10.54	650 - 950	< or = 0.01um at 12.54 um	0.625 cm^{-1} at the shortwave side of all spectral regions	< or = 0.166 at 12.54 um (800 cm^{-1}) assuming a 289 K BB	< or = 0.144 at 12.54 um
10.54--6.25	950-1600	< or = 0.008 um at 8.1 um, < or = 0.006 at 6.8 um	1.25 (TBS) cm^{-1} at the shortwave side of all spectral regions	< or = 0.092 at 6.06 um (1650 cm^{-1}) assuming a 289 K BB	< or = 0.602 at 6.06 um
4.8--4.25	2100-	< or =	1.25 cm^{-1} at the	< or = 0.01 at	< or = 0.58 at 4.55

	2350	0.0023 um at 4.25 um	shortwave side of all spectral regions	4.55 um (2195 cm^{-1}) assuming a 287 K BB	um
4.25-3.85	2351-2600	< or = 0.0018 um at 3.85 um	1.25 cm^{-1} at the shortwave side of all spectral regions	< or = 0.011 at 4.0 um (2500 cm^{-1}) assuming a 287 K BB	< or = 1.79 at 4.0 um

ID:
3311
Table 6c. Maximum allowed NEdN for the SW/M task interferometric example at the Hot Test Target Temperature listed in Table 5a. For reference, the bin size has been listed from Table 4.

Wavenumber (cm^{-1})	Bin size (cm^{-1})	Max. NEdN [mW/(m^2 sr cm^{-1})]	Corresponding NEdT values at 250 K for reference (K)
650	0.625	1.155	0.948
670	0.625	0.405	0.332
700	0.625	0.208	0.171
750	0.625	0.173	0.145
800	0.625	0.163	0.142
850	0.625	0.163	0.149
900	0.625	0.169	0.165
950	0.625	0.179	0.187
1000	0.6	0.192	0.217
1050	0.6	0.207	0.257
1100	0.6	0.221	0.305
1150	0.6	0.296	0.361
1200	0.6	0.52	0.913
1210	1.25	0.12	0.215
1258	1.25	0.066	0.135
1306	1.25	0.062	0.143
1355	1.25	0.064	0.168
1403	1.25	0.066	0.196
1451	1.25	0.068	0.234
1499	1.25	0.07	0.285
1547	1.25	0.072	0.345
1595	1.25	0.075	0.425
1644	1.25	0.077	0.519
1692	1.25	0.08	0.601
1740	1.25	0.083	0.736
2150	2.54	0.01	0.416
2202	2.54	0.01	0.507
2254	2.54	0.01	0.594
2306	2.54	0.01	0.750

2358	2.54	0.011	0.919
2410	2.54	0.011	1.124
2461	2.54	0.011	1.457
2513	2.54	0.011	1.981
2565	2.54	0.012	2.607
2617	2.54	0.012	3.324
2669	2.54	0.012	4.241
2721	2.54	0.012	5.407

ID:

3503

Table 6d. Maximum allowed NEdN for the SW/M task dispersive example at listed Test Target Temperatures. For reference, the bin size has been listed from Table 4.

Wavelength (um)	Wave-number (cm^{-1})	Bin size (um)	Bin size (cm^{-1})	Max. NEdN [mW/(m^2 sr cm^{-1})]	NEdT (K)
15.38-10.54	650 - 950	$</=$ 0.01um at 12.54 um	0.625 cm^{-1} at the shortwave side of all spectral regions	$</=$ 0.166 at 12.54 um (800 cm^{-1}) assuming a 289 K BB	$</=$ 0.144 at 12.54 um
10.54--6.25	950-1600	$</=$ 0.008 um at 8.1 um, $</=$ 0.006 at 6.8 um	1.25 (TBS) cm^{-1} at the shortwave side of all spectral regions	$</=$0.092 at 6.06 um (1650 cm^{-1}) assuming a 289 K BB	$</=$ 0.602 at 6.06 um
4.8--4.25	2100-2350	$</=$ 0.0023 um at 4.25 um	1.25 cm^{-1} at the shortwave side of all spectral regions	$</=$0.01 at 4.55 um (2195 cm^{-1}) assuming a 287 K BB	$</=$ 0.58 at 4.55 um
4.17-3.85	2400-2600	$</=$ 0.0018 um at 3.85 um	1.25 cm^{-1} at the shortwave side of all spectral regions	$</=$0.011 at 4.0 um (2500 cm^{-1}) assuming a 287 K BB	$</=$ 1.79 at 4.0 um

ID:

3540

Table 6e. Signal to noise for OO task bands. For reference, the bin size has been listed from Table 4.

Wavelength (um)	Bin size (um)	Threshold S/N	Goal S/N
0.4 -1.1 um centered at 0.667 um, or all of the bands listed below (GOAL)	0.02 (T), 0.01 (G)	> or =300:1 (TBR)	> or = 900:1 (TBR) less than 0.7 um
0.412	0.02 (T), 0.01 (G)	> or =300:1 (TBR)	> or =900:1 (TBR)
0.443 (THRESHOLD)	0.02 (T), 0.01 (G)	> or =300:1 (TBR)	> or =900:1 (TBR)
0.477	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.490 (THRESHOLD)	0.02 (T),	> or = 300:1	> or = 900:1 (TBR)

	0.01 (G)	(TBR)	
0.510	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.530 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.550 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.645 (THRESHOLD)	0.02	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.667 (THRESHOLD)	0.01	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.678	0.01	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.750	0.02 (TBR), (T), 0.01 (G)	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.763	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.865 (THRESHOLD)	0.02 (T), 0,01 (G)	> or = 300:1 (TBR)	> or = 900:1 (TBR)
0.905	0.035	> or = 300:1 (TBR)	> or = 900:1 (TBR)

ID:
3622

Table 6f. Signal to noise for CW task bands. For reference, the bin size has been listed from Table 4.

Wavelength (um)	Bin size (um)	Threshold S/N (imposed on "minimum" signal from appendix)	GOAL S/N
0.40 -1.1 um , centered at 0.667 um and 11.2, 12.3 um or all of the bands listed below (GOAL)	0.02, 0.8, 1.0	> or = 300:1 (TBR)	900 (TBR)
0.412 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.443 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.477 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.490 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.510 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.530 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.550 (THRESHOLD)	0.02 (T), 0.01 (G)	> or =300:1 (TBR)	900 (TBR)
0.645 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.667 (THRESHOLD)	0.01	> or = 300:1 (TBR)	900 (TBR)
0.678 (THRESHOLD)	0.01	> or =300:1 (TBR)	900 (TBR)
0.750 (THRESHOLD)	0.02 (TBR) (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)

0.763 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.865 (THRESHOLD)	0.02 (T), 0.01 (G)	> or = 300:1 (TBR)	900 (TBR)
0.905 (THRESHOLD)	0.035	> or = 300:1 (TBR)	900 (TBR)
1.38 (GOAL)	0.03	> or = 300:1 (TBR)	900 (TBR)
1.61 (GOAL)	0.06	> or = 300:1 (TBR)	900 (TBR)
2.26 (GOAL)	0.05	> or = 300:1 (TBR)	900 (TBR)
11.2 (GOAL)	0.8	0.1 K NEdT (TBR) at 300 K	0.05 K NEdT (TBR) at 300 K
12.3 (GOAL)	1.0	0.1 K NEdT (TBR) at 300 K	0.05 K NEdT (TBR) at 300 K

ID:
5870

0.570 (under study, goal)	0.01	> or = 300	> or = 900

ID:
3729

(2.10.2) 3.B.2.o Pixel Performance

ID:
3730

ID:
3731

(2.10.2) 3.B.2.o.1. Spectral Operability for Short Band Breaks for DS and SW/M tasks

ID:
3732
Groupings of contiguous inoperable pixels (as defined in section (2.10.2) 3.B.2.o.3) due to a short band break shall be no longer than 35 (TBS) resolution elements. The location choices of any spectral outages for short band breaks is guided by the critical spectral regions of interest identified in section (2.10.2) 3.B.2.g and retrieval analysis showing importance of spectral various spectral sub-regions. Spectral band breaks described in the spectral band break table below shall bet met.

Band	Sub-Region	Spectral Range (cm^{-1})	Contiguous Missing Threshold Channels per breaks
LWIR	1	650-665	< or =5
	2	665-672	1; 665 (+0.2/-0.1) or 667 (+0.2, -0.2)

	3	672-722	NONE
	4	722-930	< or =35
	5	930-960	< or =35
	6	960-1080	< or =5
	7	1080-1200	< or =35
MWIR (example 1)	NA	1650-2150	< or =35
MWIR (example 2)	NA	1210-1740	< or =35
SWIR	1	2150-2230	< or 20
	2	2230-2380	< or =5
	3	2380-2390	NONE
	4	2390-2570	< or =35
	5	2570-2720	< or =5

ID:
6217
Discussion: This section presents the limits on planned spectral band breaks due to the need to separate a band over multiple focal plane arrays. Unlike inoperable spectral channels (next section) which are due to random unforeseen or uncontrollable circumstances in the sensor due to, e.g., detector or electronics outages, missing channels from band breaks will always be present in all pixels. The requirements below present planned band break specifications in terms of the number of missing channels allowed in a break and the number of breaks allowed anywhere within the spectral sub-region.

ID:
3733

(2.10.2) 3.B.2.o.2. Spectral Operability *for Short Band Breaks for OO and CW tasks*

ID:
3734

The CW task shall have no band breaks (THRESHOLD) if produced from the threshold bands and fewer than two (2) band breaks if a hyperspectral (GOAL) implementation is employed.
The OO task shall have no band breaks if produced from the threshold bands and no more than 1 band break if a hyperspectral (GOAL) implementation is employed.

ID:
3735

(2.10.2) 3.B.2.o.3 General Operability

ID:
3736
For the sounding tasks of the HES, a pixel is a spatial sample and all of its associated spectral samples. For an interferometer all spectral samples occur in one detector element. For a dispersive system, spectral sample from the same ground location occur across multiple detector elements.

An inoperable pixel is therefore a pixel that is not operable as defined below for each type of instrument.

ID:
3741
A histogram of NEdN values is anticipated from all FPAs.

ID:
6071
A pixel is considered fully operable if the channels in the pixel meet all of the other channel requirements and following two conditions are satisfied:

1. The number of channels that fail the noise requirements plus the number of missing channels in planned band breaks is less than the percent failing in the spectral inoperability table below for all spectral sub-regions and
2. The number of contiguous missing channels that fail the noise requirements not including planned band breaks is less than the cluster lengths in the table below for all spectral sub-regions.

ID:
6072
A pixel is considered operable if the channels in the pixel meet all of the channel spatial, spectral, and temporal requirements and following two conditions are satisfied (note: a fully operable pixel is also operable):

1. The number of channels that fail two times the noise requirements plus the number of missing channels in planned band breaks is less than the percent failing in the spectral inoperability table below for all spectral sub-regions and
2. The number of contiguous missing channels that fail two times the noise requirements not including planned band breaks is less than the cluster lengths in the table below for all spectral sub-regions.

ID:
6073

An outage is an inoperable pixel that is defined as a non-responsive (or operationally dead) pixel when the calibrated responsivity in every channel in a band is less than 1% of the mean spectral responsivity across the sub-region of the spectral band of the FPA of interest.

ID:
6074
As a THRESHOLD for the sounding tasks, there shall be no more than 5% (TBR) outages.

ID:
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ID:
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ID:
3742
As a THRESHOLD, the instrument performing the DS and/or the SW/M tasks shall have at least 50% fully operable pixels.

ID:
3743
As a THRESHOLD, the instrument performing the DS and/or the SW/M tasks shall have at least 84% operable pixels.

ID:
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ID:
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ID:
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ID:
3740
The goal operability for all IR bands is 100%.

ID:
6075
The VIS (Band 4) shall have at least 99.9% fully operable pixels.

ID:
6214
The HES-OO Reflected < 1 um shall have at least 99.9% fully operable pixels

ID:
6076
The HES-CW Reflected < 1 um shall have at least 99.9% fully operable pixels

ID:
6077
The HES-CW Reflected > 1 um shall have at least 87% operable pixels.

ID:
6070
The HES-DS shall have no more than 0.05% (TBR) neighboring inoperable pixels in a 62 LZA frame including diagonal neighbors on a rectangular grid.

The HES-SW/M shall have no more than 0.05% (TBR) neighboring inoperable pixels in a mesoscale frame including diagonal neighbors on a rectangular grid.

ID:
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ID:
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ID:
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ID:
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ID:
6309

Spectral inoperability requirements table

Band	Sub-Region	Spectral Range (cm^{-1})	Cluster length for threshold channels
LWIR	1	650-665	< or = 5

	2	665-672	NONE
	3	672-722	< or = 5
	4	722-930	< or = 5
	5	930-960	< or = 5
	6	960-1080	< or = 5
	7	1080-1200	< or = 5
MWIR (example 1)	NA	1650-2150	< or = 5
MWIR (example 2)	NA	1210-1740	< or = 5
SWIR	1	2150-2230	< or = 5
	2	2230-2380	< or = 5
	3	2380-2390	NONE
	4	2390-2570	< or = 5
	5	2570-2720	< or = 5
Total sounding operability			
Reflected solar < 1 um	NA	0.4-1.0	0
Reflected solar > 1 um	NA	1.0-2.285	0
LWIR-CW	NA	11.2-12.3	0

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ID:
3766
A non-responsive pixel (or an outage) is one that shows less than 10% of nominal measurable change in output signal as a function of illumination.

ID:
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ID:
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ID:
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ID:
3772
For OO task: An OO task pixel is considered fully *operable* if the channels in the pixel meet all other channel requirements and the following two conditions are satisfied:

1. the number of channels that fail the noise requirements plus the number of missing channels in planned band breaks, if any, is less than the percent failing, here 0.1%.
2. the number of contiguous missing channels that fail the noise requirements not including
       planned band breaks is less than the cluster lengths of 1.

ID:
6215
A pixel is considered non-responsive, or an outage, when it is inoperable *and* the calibrated responsivity in each spectral channel is less than 10% (TBR) of the mean responsivity for the same channel across the entire focal plane array.

ID:
6216
As a THRESHOLD, the OO task **shall** have greater than or equal to the percentage of fully operable pixels, here 99.9%. As a THRESHOLD, the OO task **shall** have fewer outages than 0.1%.

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(2.10.2) 3.B.3 Navigation

ID:
3787
Navigation refers to the determination of the location of each pixel relative to a fixed reference coordinate system.

ID:
3788
Navigation of the HES and the satellite system by the ground system must be sufficient to meet the science requirements for that instrument. The breakdown between the satellite and each of the instruments will not be specified in this document. All navigation requirements listed herein apply to the end-to-end system, taking all instrument, spacecraft, and ground processing effects into account. These errors for any given pixel(s) can be determined through analysis and simulation, while on-orbit verification will require using landmarks in an image. The HES **shall** be capable of autonomously acquiring stars at the appropriate rate and accuracy, if required to meet INR requirements.

ID:
3789
Unless otherwise specified, all navigation requirements in this document are specified as North/South and East/West angles, in microradians, 3-sigma, and refer to all hours of operation. The Ground Sample Angle is the angle subtended by a single pixel at nadir so that a 10 km IR spatial resolution THRESHOLD of the DS task by definition subtends a 280 urad GSA. In addition, 3-sigma is interpreted as the arithmetic mean, plus or minus three times the square root of the variance for a population of 100 consecutive observations.

ID:
3790
In this section, "image" or "frame" are synonymous, and refer any programmed scan area data set ranging from a full disk down through the Mesoscale in pixel space, as opposed to detector sample space.

ID:
3791
Navigation error is the angular location knowledge error of pixels or features in an image.

ID:
3792
The navigation error for each HES Task shall not exceed the THRESHOLD values in the Navigation Error Table below for pixels on the Earth's disk, except during eclipse and as described in Section

(2.10.2) 3.B.15.2. The navigation error should not exceed the GOAL values in the Navigation Error Table below except during eclipse and as described in Section (2.10.2) 3.B.15.2.

ID:
3793
Navigation Error Table

HES Task	THRESHOLD	Goal
DS	0.5 IR GSA	0.25 IR GSA
SW/M	0.5 IR GSA	0.25 IR GSA
CW	9 urad (TBR)	7 (TBR) urad
OO	0.5 GSA, for 56 urad max	0.4 GSA, for 44.8 urad max

ID:
3815

(2.10.2) 3.B.4. Data format

ID:
3816
Level 1b data, defined as the final calibrated, navigated HES data output, shall be radiance spectra.

ID:
3817
Discussion: The data format must allow integration of HES data with other NOAA's NWS data sources. To facilitate data use and integration, level 1b data will be distributed. While a 'fixed grid' projection makes sense for the ABI system, due to the non-linear nature and use of the sounder data, the native format is preferred.

ID:
3818
Benefits: In addition to users of the spectra for meteorological applications, this will allow a host of new users in diverse fields of chemistry and land processes.

ID:
3819

(2.10.2) 3.B.5. Co-registration

ID:
3820
Channel to channel registration, or co-registration errors, between IR bands involved in the same task for the DS task and the SW/M task shall not exceed ¼ of the IR GSA (0.25*IR IFOV at the SSP) (THRESHOLD) and 10% of the IR GSA (0.10*IR IFOV at SSP) (GOAL) and shall be acquired nearly simultaneously (see section 3.B.10). If the GSD is not the same for the bands particularly as in the case of the visible band (see 3.B.2.d), then multiple samples from the higher resolution must be combined to

match the GSD of the coarser resolution sample. If all channels are observed simultaneously, then the co-registration error collapse to errors of overlapping images. In this case, it in anticipated that the co-registration error would be determined from array image overlap and as such knowledge of the actual co-registration errors at the corners of each array is required so that the shift and the rotation can be determined for all pixels. This shall occur after known optical distortions are characterized and taken into account. If all of the channels are not observed simultaneously, then spacecraft effects will impact the co-registration, increasing the difference in the navigation errors between channels over the scenario of simultaneous observations.

ID:
3821

ID:
3822
If either meeting ¼ of the IR IFOV (THRESHOLD) at the SSP (¼ IR GSA) or meeting 10% or better of the IR IFOV (GOAL) at the SSP (10% of IR GSA) is considered a significant cost driver, the contractors should spell out expected cost versus co-registration error.

ID:
3823
The visible-IR co-registration error for the DS task shall be less than or equal to ¼ of the IR IFOV (THRESHOLD) at the SSP (1/4 IR GSA) (TBR) and less than or equal to 1/10 of the IR IFOV at the SSP (1/10 IR GSA) (TBR) (GOAL).

ID:
3824
The visible-IR co-registration error for the SW/M task shall be less than or equal to ¼ of the IR IFOV (THRESHOLD) at the SSP (1/4 IR GSA) (TBR) and shall be less than or equal to 1/10 of the IR IFOV at the SSP (1/10 IR GSA) (TBR) (GOAL).

ID:
3825
The co-registration error of the reflected solar bands of the OO task shall be less than or equal to 1/4 of the IR IFOV at the SSP (1/4 IR GSA) (TBR) (THRESHOLD) and 1/10 of the IR IFOV at the SSP (1/10 IR GSA) (TBR) (GOAL).

ID:
3826
The co-registration error of the reflected solar bands < 1 um of the CW task shall be less than or equal to 9 microradians (0.3 km at the SSP) (TBR) (THRESHOLD) and less than or equal to 3 microradians (0.25 km at the SSP) (TBR) (GOAL). The co-registration error of the reflected solar bands < 1 um of the CW task to the both the reflected solar > 1 um bands of the CW task and the reflected solar < 1 um bands of the CW task shall be less than or equal to 9 microradians (0.3 km at the SSP) (TBR) (THRESHOLD) and less than or equal to 3 urad (TBR) (0.25 km at the SSP) (GOAL). The co-registration error of the GOAL LWIR bands of the CW task to the reflected solar bands < 1 um of the

CW task and the reflected solar > 1 um shall be less than or equal to 14 microradians (0.5 km at the SSP) (TBR) (THRESHOLD) and less than or equal to 7 urad (0.25 km at the SSP) (GOAL).

ID:
3827
Benefits: Since the sounding process for the DS task and/or the SW/M task involves the combination of data from each of the individual spectral regions, it is vital that each of the spectral regions view as closely as possible the same area of the earth nearly simultaneously, with similar scene-spread functions. Although not a sounding the bands employed in either the OO or CW tasks should also view as closely as possible the same area of the earth nearly simultaneously, with similar scene-spread functions within each task because difference products involving multiple bands will be formed. This becomes especially important in regions of strong gradients.

ID:
3828

ID:
3829

(2.10.2) 3.B.6. Removed

ID:
3830

(2.10.2) 3.B.7. Within Frame Registration.

ID:
3831

ID:
3832
All registration requirements listed herein apply to the end-to-end system, taking all instrument, spacecraft, and ground processing effects into account. In this section, "image" or "frame" are synonymous, and refer any programmed scan area data set ranging from a full disk down through the Mesoscale in pixel space, as opposed to detector sample space.

ID:
3833
Unless otherwise specified, all registration requirements in this document are specified as North/South and East/West angles, in microradians, 3-sigma, and refer to all hours of operation. The Ground Sample Angle is the angle subtended by a single pixel at nadir so that a 10 km IR spatial resolution THRESHOLD of the DS task by definition subtends a 280 urad GSA. In addition, 3-sigma is interpreted as the arithmetic mean, plus or minus three times the square root of the variance for a population of 100 consecutive observations.

ID:
3834

(2.10.2) 3.B.7.a. Within Frame, Non-Adjacent Pixel Registration

ID:
3835
Within-frame but non-adjacent registration error is the difference between the measured and nominal distance between any two non-adjacent pixels in an image. Within-frame but non-adjacent registration error shall not exceed the THRESHOLD values in the Within Frame, Non-adjacent Pixel Registration Table below. Within-frame but non-adjacent registration error should not exceed the GOAL values in the Within Frame, Non-adjacent Pixel Registration Table below.

ID:
3836
Within Frame, Non-Adjacent Pixels Table

HES Task	THRESHOLD	GOAL
DS	0.5 IR GSA	0.25 IR GSA
SW/M	0.5 IR GSA	0.25 IR GSA
CW	1.0 (TBR) GSA or 9 urad (TBR)	7 urad (TBR)
OO	0.5 IR GSA	0.25 IR GSA
ABI Back-up mode	0.5 * Vendor IR GSA	42 urad over 120 min (GOES-O equiv.) (TBR)

ID:
3862

(2.10.2) 3.B.7.b. Within Frame, Adjacent Pixel Registration

ID:
3863
Within-frame and adjacent registration error is the difference between the measured and nominal distance between any two adjacent pixels in an image, including line to line and single integration image to single integration image. Within-frame and adjacent registration error shall not exceed the THRESHOLD values in Within Frame, Adjacent Pixel Table below. Within-frame and adjacent registration error should not exceed the GOAL values in Within Frame, Adjacent Pixel Table below.

ID:
3864
Within Frame, Adjacent Pixels Table

HES Task	THRESHOLD	GOAL
DS	0.5 IR GSA	0.25 IR GSA
SW/M	0.5 IR GSA	0.25 IR GSA
CW	1.0 (TBR) GSA or 9 urad max (TBR)	7 urad (TBR)

OO	0.5 IR GSA	0.25 IR GSA
ABI backup mode	0.5 * Vendor IR GSA	20 urad (TBR) over 120 min (GOES-O equiv.)

ID:
3890
Discussion: These requirements are intended to define the limits of acceptable within- image distortions. There will be DS task and/or SW/M task products based on and displayed for each pixel location. There will also be OO and CW products for each pixel.

ID:
3891
Benefits: Since a major use of the DS task and SW/M task data will be in providing information contained in the gradients of the observations, the relative locations are critical.

ID:
3892

(2.10.2) 3.B.8. Frame-to-Frame Registration

ID:
3893
Introductory description in section (2.10.2) 3.B.7 applies here as well.

ID:
3894
Frame to frame registration error is the difference in navigation error for any given pixel in two consecutive images. Since images may be 60 minutes apart, these requirements apply over 60 minute periods. Frame to frame registration errors shall not exceed the THRESHOLD values in the Frame-to-Frame Navigation Table. Frame to frame registration error should not exceed the GOAL values in the Frame-to-Frame Navigation Table.

ID:
3895
Frame-to-Frame Navigation Table

HES Task	THRESHOLD	GOAL
DS	0.5 IR GSA (TBR) over 60 minutes	0.25 IR GSA (TBR) over 60 minutes
SW/M	0.5 IR GSA (TBR) over 60 minutes	0.25 IR GSA (TBR) over 60 minutes
CW	1.0 (TBR) GSA, or 9 urad (TBR), over 60 minutes	7 urad (TBR), over 60 minutes
OO	0.5 IR GSA (TBR) over 60 minutes	0.25 IR GSA (TBR) over 60 minutes
ABI backup mode	0.5 * Vendor IR GSA (TBR) over 60 minutes	42 urad (TBR) over 90 min; 112 urad (TBR) over 24 hours (GOES-O equiv.)

ID:
3921

(2.10.2) 3.B.9. Removed

ID:
3922

(2.10.2) 3.B.10. Data simultaneity

ID:
3923

(2.10.2) 3.B.10.a Band to band Simultaneity

ID:
3924
Data from all bands for the HES-DS task obtained for any specific point on Earth must be coincident within 10 (TBR) seconds (THRESHOLD) and within 5 seconds (GOAL). These values are not to exceed values.

ID:
3925
Data form all bands for the HES-SW/M task obtained for any specific point on Earth must be coincident within 10 (TBR) seconds (THRESHOLD) and within 5 seconds (GOAL).

ID:
3926
Data from all bands for the HES-OO task obtained for any specific point on Earth must be coincident within 30 (TBR) seconds (THRESHOLD) and within 20 seconds (GOAL). These values are not to exceed values.

ID:
3927
Data from all bands for the HES-CW task obtained for any specific point on Earth must be coincident within (TBR) seconds (THRESHOLD) and within 10 seconds (GOAL). These values are not to exceed values.

ID:
3928
Discussion: The simultaneity requirements for the DS, SW/M, OO and CW tasks are needed to ensure accurate generation of any multiband products that depend on data from all spectral bands. In particular, this requirement is imposed to attempt to ensure that cloud cover is consistent during the observations.

ID:

3929
Benefits: Minimizes uncertainty due to cloud contamination and solar heating.

ID:
3930

(2.10.2) 3.B.10.b Pixel to pixel simultaneity

ID:
3931
Data from all adjacent pixels in all adjacent FOVs from the DS task must be sampled within a maximum of 6 minutes (THRESHOLD) of each other when covering the 62-degree local zenith angle and within 3 minutes (THRESHOLD) when covering a CONUS-sized area (defining the swath length), while meeting the coverage rate define in section 3.A.2. The GOAL simultaneity for a CONUS-sized area is 2 minutes, based on the current sounder. These values are not to exceed values.

ID:
3932
Data from all adjacent pixels in all adjacent FOVs from the SW/M task must be sampled within 6 minutes (THRESHOLD) when covering a CONUS-sized area (if collected at part of the 62 degree LZA collection)) and within 3 minutes when covering a 1000 km x 1000 km area, while meeting the coverage rate defined in 3.A.2. The GOAL simultaneity for a CONUS-sized area is 2 minutes, based on the current sounder. These values are not to exceed values.

ID:
3933
Data from all adjacent pixels in all adjacent FOVs from the OO task must be sampled within 18 TBR minute (THRESHOLD) when covering the open ocean in the 62 degree LZA (defining the swath length) while meeting the coverage rate defined in 3.A.2. The GOAL simultaneity is 13 minutes TBR when covering the open ocean in the 62-degree LZA (defining the swath length) while meeting the coverage rate defined in 3.A.2. These values are not to exceed values.

ID:
3934
Data from all adjacent pixels in all adjacent FOVs from the CW task must be sampled within 10 minutes (TBR) minute (THRESHOLD) when covering a 400 km-length (defining the swath length) while meeting the coverage rate defined in 3.A.2. For simultaneous coverage of larger areas than 400 km x 400 km, the simultaneity shall increase linearly with the length observed (i.e. 1200 km x 400 km simultaneous coverage would implies a pixel to pixel simultaneity of 30 minutes). The GOAL simultaneity is TBD when covering the 62-degree LZA (defining the swath length) while meeting the coverage rate defined in 3.A.2. These values are not to exceed values. For the localized mode of this task only (staring capability under study) only, 2 minute simultaneity is permitted for areas smaller than 4000 km x 400 km.

ID:
3935

The <u>dominant direction of instrument "scan"</u> must be in the East-West directions for the DS, SW/M and OO tasks. There is no dominant direction of scan for the CW task. To accommodate a possible seasonal Yaw flip (similar to that on the GOES-10 spacecraft), stepping shall be possible in North to South, South to North, West to East, and East to West directions. Ground sample data acquisition <u>should</u> begin with the northernmost coordinate and proceed south. See Section (3.B.13) concerning scan effects on calibration.

ID:
3936
Discussion: The pixel-to-pixel simultaneity requirements for the DS, SW/M, OO and CW tasks are needed to minimize time gaps across swaths. This limits shear between swaths. The pixel-to-pixel simultaneity does not apply outside of its task.

ID:
3937

(2.10.2) 3.B.11. Full Operations

ID:
3938
    The HES shall be capable of full operations within 1 hour (TBR) following North-South station-keeping spacecraft maneuvers (THRESHOLD).

ID:
3939
Discussion: Routine operations should not be re-established too quickly to endanger the health or safety of the instrument. The design should minimize degradation to navigation ability from sun exposure on the scan mirror and the rest of the imager.

ID:
3940
Benefits: Excessive delays in resuming routine imaging operations following mandatory outages associated with maneuvers can threaten continuity of weather surveillance and result in degradation of forecasts of severe weather.

ID:
3941

(2.10.2) 3.B.12. Visible band calibration for DS and SW/M tasks

ID:
3942
The visible band of the DS task and/or of the SW/M task shall be calibrated prior to launch to provide albedo to an accuracy of +/- 5% at maximum scene radiance. This visible calibration performed pre-launch should be stable and compared to a NIST reference. The DS and the SW/M visible band(s) shall be quantized in such a way that the signal will not saturate (high counts or low counts) over the life of the instrument and under worst-case conditions. It is anticipated that vicarious calibration will be

performed during the life of the instrument performing these tasks. Also, the presence of a reflected solar wavelength calibration on board the ABI and HES should facilitate this calibration process. The required accuracy of that intercalibration will be 5%.

ID:
3943
The calibration required for the reflected solar bands of the OO or CW tasks is discussed in section 3.B.14.

ID:
3944

(2.10.2) 3.B.13. Infrared Calibration for DS and SW/M tasks

ID:
3945
On-orbit and ground calibration must be provided to achieve brightness temperature absolute accuracy of ± 1.0 K (THRESHOLD) for each band and traceable to a NIST radiance standard. (The absolute accuracy requirement means that if the true value for a band is X K, then the calculated values must be between X minus 1 and X plus 1 K.) The GOAL value is 0.5 K A cold reference may be provided by a space look. The relative accuracy (precision) of each band shall be within the NEdN (THRESHOLD) and within 1/3 of the NEdN (GOAL) (1-sigma) for the following categories of relative error: a) swath to swath (where a swath is one traversal of the scan mirror in the east-west directions over the entire scene of interest), b) detector to detector, c) channel to channel, d) calibration to calibration. Optical and structural elements that influence the radiometric response of the instrument to the calibration blackbody shall be temperature monitored such that the corrections to the scene due to these sources will be good to < or = 0.1 K precisions between IR calibrations and telemetered for calibration ground processing.

ID:
3946
The "hot" calibration target will be a blackbody. The calibration method is required to account for both long-term variations such as changing emissivities of the optical elements in front of the blackbody (including scan mirror degradation) and short-term variations such as gain variations of the FPA. It is anticipated that either the 1) the blackbody will be viewed by a rotation of the scan mirror to provide calibration of the entire system or 2) the blackbody will be located inside the optical train and will be accessible by a flip mirror. If option 2 is chosen, a detailed analysis using to the maximum feasible extent current on-orbit instruments data shall be performed to demonstrate that the impact of the approach over the life of the instrument is no greater than the impact from using option 1. At NOAA's discretion, data from end-to-end ground testing may be deemed acceptable in these calculations.

ID:
3947
Radiometric accuracy of the HES system in the DS and SW/M tasks should be independent of scan position (or location of the target in the field of regard). Independent of scan position implies change of less than 0.6 (TBR) % relative to the scene dynamic range with angle. All calibration tolerances are 3-sigma.

ID:
3948

Benefits: All soundings and products rely on accurate calibration.
Discussion: Quantitative products derived from imager data for weather forecasting demand stable, calibrated data. Accurate knowledge of the system spectral response function (SRF), including both in-band and out-of-band response, is required for each band and the on-board black body is required. Relative precision includes line-to-line, detector-to-detector, and frame-to-frame repeatability of the measurement of the brightness temperature of a uniform scene.

ID:
3949

(2.10.2) 3.B.14. Reflective solar calibration and polarization control for the OO task and CW task

ID:
3950

Because the IR bands of these tasks do not lie in the thermal IR range (except two bands in the CW task), the IR bands fall into the reflective solar range. The reflective solar of the OO or CW tasks shall be calibrated prior to launch to provide albedo to an accuracy of 3 (TBR) % at maximum scene radiance, listed as "maximum" in the appendix. This reflective solar calibration performed pre-launch should be stable and compared to a NIST reference. Signal from these reflective solar bands shall be quantized in such a way that the signal will not saturate (high counts or low counts) over the life of the instrument and under worst-case conditions. An onboard full optical train, full aperture calibrator shall be used to perform calibrations during the life of the instrument performing these tasks (see discussion). The require calibration must provide absolute accuracy of 3% or less at 100% albedo, RMS (short-term)repeatability of the band difference of +/-0.2% or less, and drift in absolute calibrated radiances of 0.5% over the instrument lifetime. *Relative calibrations accuracy shall be 1% or better. *
For the LWIR bands of the CW task, the IR calibration described in 3.B.13. above applies.

ID:
6050

b) On-board "visible" and reflective solar < 3 um calibration for the OO and CW tasks shall also provide:

ID:
6054

  1. Radiance measurements in the reflected solar wavelength range shall be traceable to NIST standards. Traceability is defined as the property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties. (International Vocabulary of Basic and General Terms in Metrology, 1993; used by NIST. The Government assesses the vendors demonstrations of radiance traceability to NIST, which the

vendor establishes through both 1) a measurement assurance program (an example of which is the purchasing of NIST sources (e.g., lamps, blackbodies) with adherence to specified recalibration schedules pre-launch), and 2) use of NIST best practices in radiance determinations, including quality programs detailing measurement procedures and reproducibility and using trained personnel.

ID:
6055

2. The on-board calibration for the solar reflective bands shall be performed at least once a month under routine operations and more frequently (e.g., once a day) during post-launch phase where rapid changes are anticipated.

ID:
6056

3. The calibration shall also employ a technique involving measurements to address long-term stability for the solar reflective wavelengths.

ID:
6057

4. The instrument vendor shall perform at least a pre-launch full-system radiometric calibration in all bands, filling the aperture and the entire optics/detector train as under the operational conditions.

ID:
6058

5. The vendor shall characterize the spectral response as a function of wavelength for each optical element in the optical train.

ID:
6059

6. An independent laboratory approved by the government shall measure the spectral response of witness samples of the critical optical elements, namely the bandpass optical filters.

ID:
6060

Discussion: NOAA wants an onboard, reflected solar < 3 um calibration capability, but it must not introduce significant costs or risks through its approach or technology to the HES's lifetime. A failure of the onboard calibration device shall not cause failure of the entire HES mission. Complementary multiple techniques can be used to implement calibration. A NOAA workshop held on May 19, 1999 explored the availability of onboard ABI visible and near IR technologies and approaches. The results of the workshop are contained in JPL report "In Flight Visible and Near Infrared Calibration of Future

GOES Imagers Workshop report," Dave Norris, October 1999, JPL report D-17846. The above onboard calibration requirements identified at the workshop were discussed as limits of what could be achieved. Ultimately, the lowest GPRD product accuracy of 5% is the driver. Thus the radiometric calibration will be tighter, at 3%. What NOAA wants is an onboard capability and some progress towards these limits.

ID:
6061
Alternative Imager, on-board, reflected solar < 3 um calibration designs were discussed, such as

ID:
6062
    1. Stable on-board source of illumination;

ID:
6063
    2. The sun as a radiometric source via, e.g., reflection from diffuser plates or transmission through perforated plates.

ID:
6064
Standard diodes could be used with the preceding approaches to monitor the output of the on-board source, the reflectivity of the diffuser plate, or the transmittance of the perforated plate.

ID:
6049
Discussion: Instrument intercomparison across platforms in all wavebands will be performed by NOAA, but nothing additional is mandated to the instrument vendor because of this plan.

ID:
3951
All HES channels other than the visible cloud clearing channels of the DS and SW/M tasks with wavelengths <3 microns shall have less than 3 (TBR) % (THRESHOLD) sensitivity to the polarization of incoming light, and, as a goal, they should have less than 1 (GOAL)% (TBR) sensitivity. (See definition of polarization sensitivity in next paragraph.) The difference in sensitivity to polarization between channels shall be less than 2.0% (TBR), with a goal of less than 1.0% (TBR). The uncertainty in the sensitivity to polarization within a channel shall be less than 1% (TBR), with a goal of 0.5% (TBR). The polarization insensitivity requirements shall be met at all Earth-viewing angles throughout the life of the mission, and, as a goal, the insensitivity requirements should be met over the entire field-of-regard.

ID:
3952
Polarization sensitivity is defined as the ratio of the difference between maximum and minimum output to the sum of the maximum and minimum output obtained when the plane of incoming 100% linearly polarized radiation is rotated through 180 degrees.

ID:
3953
Discussion: In NOAA's experience, vicarious calibration provides 5 percent calibration errors while on-board calibration delivers 3% errors. Also, vicarious calibration requires months to years to complete, which is considered too long by NOAA. Because a failure of the on-board calibrator could cause a mission failure if the calibrator blocked the optical path, care must be taken in its design.

ID:
3954

(2.10.2) 3.B.15. Degradation of performance around spacecraft local midnight and around eclipse

ID:
3955

ID:
3956
(2.10.2) 3.B.15.1 Degradation around local midnight

ID:
3957

ID:
3958
Degradation of performance or outages around spacecraft local midnight must be minimized:

ID:
3959
a) Any (thermal IR) radiometric degradation reducing data quality to below specification for the DS task or the SW/M task resulting from sunlight impingement on sounder optics must be limited to when the sun is within 10 degrees of the sounder optical line of sight for each detector element (THRESHOLD).

ID:
3960
b) Any HES outages needed to ensure health and safety of the instrument when sunlight may enter the instrument optics must be limited to when the sun is within 3 degrees of any detector element's line of sight (THRESHOLD).

ID:
3961
c) No IR detector shall saturate.

ID:
3962
(2.10.2) 3.B.15.2 Degradation during eclipse

ID:
3963
a) For the DS task and or the SW/M task, all operable detector elements in the emitted IR bands (650 to 2250 cm^{-1}) shall have NEdN values no more than two (2) times their respective NEdN values under normal operating conditions. See section 3.B.2. Operable detectors are defined in section 3.B.2.o. NEdN values under normal operating conditions are listed in section 3.B.2.m (Table 5a and Table 5b). Requirements placed on the FPA pixels to meet these NEdN values are described in section 3.B.2.o. Recovery time is described in section (2.10.2) 3.B.

ID:
3964
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ID:
3965
c). The calibration performance shall degrade by no more than TBD (THRESHOLD) and 0.5 K (Goal) for a four hour time period, nominally ½ hour prior to an eclipse to 3.5 hours, after the end of an eclipse (also see section 3.B.12). The phasing of the delay may be design dependent.

ID:
3966
d) Image Navigation and Registration shall be permitted to degrade over a 4 hour period near the eclipse. The phase of the period may be design dependent. All eclipse thresholds are written in the form of angles. The Ground Sample Angle is the angle subtended by a single pixel at nadir so that a 10 km IR spatial resolution THRESHOLD of the DS task by definition subtends a 280 urad GSA. The eclipse THRESHOLD level of the navigation requirement for the DS task is 0.75 of the IR detector element IFOV. The eclipse THRESHOLD level of the navigation requirement for the SW task is 0.75 of the IR detector element IFOV. The eclipse THRESHOLD level of the navigation requirement for the CW task is 13.5 urad. The eclipse THRESHOLD level of the navigation requirement for the OO task is 42 urad. The eclipse THRESHOLD level of the navigation requirement for the ABI backup mode is 0.75*(Vendor IR IFOV). For all tasks, the eclipse GOAL navigation is the same as the goal navigation described in section

ID:
3967
   Discussion: Section 3.A.1 contains further discussion. Thorough analysis and innovative designs are encouraged to minimize this "keep-out-zone" phenomenon.

ID:
3968

Benefits: See Section 3.A.1 for further benefits. If the "keep-out-zone" phenomenon is minimized, both more and higher quality data can be observed.

ID:
3969

(2.10.2) 3.B.16. Contemporaneous visible imaging capability

ID:
3970
Contemporaneous and collocated visible data are required with the IR data for the DS task and/or the SW/M task. The spectral range is no larger than 0.52 to 0.7 µm. The signal to noise shall be greater than or equal to 300:1 (THRESHOLD) and 600:1 (GOAL) at the 100% albedo level. The resolution shall be 1.0 km (THRESHOLD) with 0.5 km (GOAL).

ID:
3971
Discussion: A serious handicap to producing accurate infrared only sounding retrievals is the difficulty of dealing with cloud contamination. Experience has shown that visible data are of great benefit during daylight hours for identifying cloud-free FOVs, especially the higher resolution visible data (sub-IR pixel size). Perhaps more importantly, however, high-resolution visible data may allow for correcting IR radiances for subpixel cloud contamination, permitting retrievals of clear air sounding and cloud information in more of the meteorologically active areas. High-resolution sounders such as the HES can anticipate frequent cloud contamination near storm systems so that sounding will improve with contemporaneous and collocated high-resolution visible data.

ID:
3972

(2.10.2) 3.B.17. Low-light Visible capability

ID:
3973
In order to address NOAA's NWS need for soundings under all conditions for the DS task and/or the SW/M task, detection of clouds under the lowest low light situations is required. These occur past sunset at the ground point of interest and extend as far as possible into night conditions. The THRESHOLD signal to noise level is 10 (TBR) over a 2 km sample using 5% albedo, although the signal levels mentioned above are even lower.

ID:
3974

ID:
3975

Discussion: Due to the increased dwell times compared to an imager, the sounder visible data may be more sensitive in low-light regions.

ID:
3976

ID:
3977
Benefits: Better depiction of near nighttime fog, clouds, and thunderstorms would be a benefit for soundings. This may also improve knowledge of the location of the center of tropical disturbances.

ID:
3978

(2.10.2) 3.B.18. Downlink Data

ID:
3979
It is assumed that the GOES spacecraft communications sub-system will serve to relay HES data to NOAA ground receive systems in near real time to address latency requirements.

ID:
3980

(2.10.2)   3.B.19. Data compression acceptability

ID:
3981
Commandable data compression that offers a choice between lossless compression (approximately 2:1) and lossy (approximately 4:1 or possibly high) should be afforded.

ID:
3982

(2.10.2) 3.B.20. Spectral Knowledge and Stability

ID:
3983
Knowledge of the spectral line center shall be 1 part in 10^5 (TBR) or better (smaller) over all time at all wavenumbers and wavelengths.

ID:
3984
Line center stability (GOAL) shall be 3 parts in 10^5 (TBR) over all time.

ID:
3985
Discussion: This level of performance is estimated to be required for good retrieval performance. The technical difficulty in maintaining this value must be assessed.

ID:
3986

(2.10.2) 3.B.21 Spectral Purity

ID:
3987
For the sounding tasks, the integrated absolute value of the spectral response from outside the channel of interest **shall** be less than 28% (TBR) of the total spectral response in the channel for a uniformly illuminated aperture.

ID:
3988
BLANK

ID:
3989

2.10.3 Removed

ID:
3990

2.10.4 Space Weather Instrument Properties

ID:
3991
Each GPRD-1 product requirement for the space weather instruments leads to a separate instrument. Thus the GPRD requirements are the same as the MRD requirements summarized in the tables through this section. All requirements, including those in the text of this section, will be met/addressed by the magnetometer (considered part of the spacecraft), the SIS, and the SEISS described immediately below. For reference only, additional P^3I products are currently listed in Appendix A.

ID:
3992
General

ID:
3993

Space Weather will be measured on GOES-R with the magnetometer and the following 2 suites: the Solar Imaging Suite (SIS) and the Space Environment In-Situ Suite (SEISS) described below. The SIS and the SEISS on GOES-R will monitor the solar EUV (extreme ultraviolet) and X-ray output and the geosynchronous particle environment. The magnetometer will monitor the magnetic environment. The SIS consists of the Solar X-ray imager (SXI), the solar X-ray sensor (XRS), and an extreme ultraviolet sensor (EUVS). The coronagraph will be part of the SIS, but is considered P³I. The SEISS consists of a set of energetic particle sensors including the Energetic Heavy Ion Sensor (EHIS), the Magnetospheric Electron and Proton Sensor (MPS) and the Solar and Galactic Proton Sensor (SGPS) that will monitor the particles at geosynchronous orbit. The three-axis vector magnetometer will monitor the geomagnetic field.

ID:
3994
The magnetometer is designed to measure the Earth's magnetic field at geosynchronous orbit. The SIS and SEISS suites of instruments are designed to provide real-time measurement of solar activity and the charged particle environment in geosynchronous orbit. The SXI and the coronagraph provide continuous images of the solar disk in X-ray and white light images of the solar corona, respectively.

ID:
3995
The magnetometer, SIS, and SEISS shall operate and transmit data during eclipses. Each instrument shall operate independently.

ID:
3996
All space and solar condition measurements from GOES-R shall be in real time.

ID:
6397
     All instrument of the SIS and SEISS shall be designed for an 8.4 year Mean Mission Duration (MMD) at the end of 10 years. The MMD is the integrated area under the instrument reliability versus time curve from t = 5 years to t = 15 years, divided by the reliability estimated at 5 years.

Discussion: This mean that a 10-year instrument-on life shall be supported with Reliability (R) of 0.6.

ID:
3997
Products from the GOES-R SIS and SEISS shall provide continuity with GOES existing products, while improving performance.

ID:
3998
Discussion: In particular, the magnetometer, particle sensors, and solar X-Ray sensor of the Space Environment Monitor (SEM) suite in the previous series have a long history of archived data that have proved to be especially useful for many areas of research and space climatology. These space environment measurements made by GOES have become standards for the space weather users.

Beginning with GOES 12, the Solar X-ray Imager (SXI), and beginning with GOES N, the EUV sensors represent new observations that will be used as new standards for space weather forecasters and users.

ID:
3999
In accordance with this continuity, the requirements for the instruments are listed below; where not specifically indicated, the threshold and goal requirements are the same.

ID:
4000

2.10.4.1 Magnetometer

ID:
4001
General

ID:
4002
The Magnetometer shall measure the magnitude and direction of the Earth's ambient magnetic field in three orthogonal directions in an Earth-referenced coordinate system.

ID:
4003
Discussion: A magnetometer provides a map of the space environment that controls charged particle dynamics in the outer region of the magnetosphere. Magnetic field measurements provide information on the general level of geomagnetic activity, monitor current systems in space, and permit detection of magnetopause crossings, storm sudden commencements, and substorms.

ID:
4004
There shall be a magnetometer on orbit for each satellite position, under normal operating conditions.

ID:
4005
The observational parameters and requirements for the magnetometer, listed in the GOES Magnetometer Observational Requirements Table, shall be met.

ID:
4006
All calibration information and algorithms necessary for determination of the ambient field shall be supplied.

ID:
4007

Data must be transmitted to enable the sensor data to be corrected in real time at the SEC; all correction algorithms are required.

ID:
4008
Data Sampling Rate

ID:
4009
Data for determining each component of the ambient magnetic field shall be sampled at a rate listed in the table below. The effective time of each measurement shall be known and each individual component shall be sampled uniformly in time and simultaneously within 25% of the sample period (i.e., within 0.125 seconds for a 2 Hz sampling rate).

ID:
4010
Bandwidth

ID:
4011
The frequency response of the instrument shall discriminate against aliasing of the magnetometer data resulting from the ambient background and spacecraft interference. For a 2 Hz sampling rate, the nominal measurement bandwidth for each component of the vector field shall be defined by a pre-sampling filter such as a fifth order Butterworth filter, with greater than 25 dB attenuation at the Nyquist folding frequency. The nominal 3 dB attenuation frequency shall be one-half the Nyquist folding frequency, with the three components matched to the nominal 3 dB frequency $\pm\,0.75\%$. The actual frequency response of the measurement shall not deviate from the nominal by more than 0.3 dB in amplitude or $5°$ in phase anywhere within the nominal 3 dB bandwidth. For a higher sampling rate, the requirement is TBD.

ID:
4012
Noise

ID:
4013
The estimate of the magnitude of the ambient field computed on the ground from the instrument measurement along each axis shall not fluctuate by more than 0.3 nT (THRESHOLD) when the spacecraft is in a normal operational mode. Unavoidable step changes, which create out-of-specification transients after ground correction, may occur. They shall not, however, average more than one transient in any one-hour period; and the duration of the out-of-specification transient shall be no greater than five seconds.

ID:
4014
In-flight Calibration

ID:
4015
An on-orbit capability shall be provided to demonstrate that the basic instrument is functional.

ID:
4016
Discussion: This shall be accomplished by adding known fields to the ambient field by ground command.

ID:
4017
A capability shall be provided to determine from the calibration data the sensitivities necessary for calculating the ambient-plus-spacecraft field. This determination shall include calibration field levels covering more than 50% of the full range of the magnetometer.

ID:
4018
The calibration shall also be stable and repeatable during times of quiet ambient field to an accuracy of ±1 nT in each axis at each field level. Magnetometer calibration shall be terminated by ground command.

ID:
4019

ID:
4020
In-flight Magnetometer Effective Offset Determination

ID:
4021
The effective magnetometer instrument offset (instrument plus spacecraft) shall be determined on-orbit via a spacecraft rotation maneuver. The instrument-offset determination shall be made during the spacecraft post-launch test period in the vicinity of local noon,

ID:
4022
Discussion: The design should eliminate spacecraft static and dynamic fields at the instrument location in order to facilitate ground-based data processing. Particular care should be taken to eliminate permeable and permanent magnetic material close to the instrument. A ground test program is necessary to demonstrate that on-orbit specifications will be met: examples included spacecraft stray and DC magnetic interference testing

ID:
4023

2.10.4.1.1 GOES Magnetometer Observational Requirements

Observational parameter	Requirement
Measurement range	+/-400 nT/axis
Measurement precision	0.016nT/axis
Measurement accuracy	1.0 nT/axis
Orthogonality	+/- 0.5 deg, 3 axes
Orientation stability	+/- 0.25 deg (TBR)
Orientation knowledge	Threshold: +/- 1 deg, Goal: +/- 0.5 deg
Refresh rate (per axis)	Threshold: 2 Hz, Goal: 8 Hz
Data Latency	Real time (5 sec)

ID:
4052

2.10.4.2 Particle sensors

ID:
4053
The SEISS particle sensors shall monitor the proton, electron, and heavy ion fluxes at geosynchronous orbit.

ID:
4054
Discussion: These particle fluxes roughly consist of three components: 1) a geomagnetically trapped and highly variable population of electrons and protons 2) sporadic fluxes of electrons, protons, and heavy ions of direct solar origin and 3) the galactic cosmic background. Knowledge of the near-Earth energetic particle environment is important in establishing the natural radiation hazard to humans at high altitudes and in space, as well as risk assessment and warning of episodes of surface charging, deep dielectric charging, and single event upsets of satellite systems. Energetic particle precipitation into the Earth's ionosphere also causes disturbance and disruption of radio communications and navigation systems. These impacts may be mitigated by early warnings of high flux episodes.

ID:
4055
The particle sensors include a magnetospheric particle sensor (MPS), an energetic heavy ion sensor (EHIS), and a solar and galactic proton sensor (SGPS). The particle sensors shall be located on a satellite with a magnetometer.

ID:
4056
The observational parameters and requirements for all particle sensors listed in the GOES Magnetospheric Particle Sensor Requirements Table, the GOES Solar and Galactic Proton Sensor Requirements Table, and the GOES Energetic Heavy Ion Sensor Requirements Table below shall be met.

ID:
4057
Discussion: The energy range of the > 2 MeV electron energy channels has been chosen to provide continuity with prior measurements.

ID:
4058
Noise

ID:
4059
For bands below 30 keV, the total instrument noise (including that from the detector, background, and electronics) shall not exceed 10% of the energy resolution. For bands with threshold energies between 30 keV and 100 keV, noise shall not widen the effective response by more than 10 keV. For bands above 100keV, noise shall not widen the effective response by more than 10% of a band's threshold energy.

ID:
4060
Stability

ID:
4061
The electronic thresholds defining the energy band edges shall not change by more than +/- 3% over the predicted operating conditions.

ID:
4062
In-flight Calibration

ID:
4063
An in-flight calibration mode shall be provided to verify basic instrument operation and to determine the value of energy band edges.

ID:
4064
Electronic discriminator levels shall be determined to ±3%.

ID:
4065
Discussion: Previous experience has indicated that the calibration mode, which is both self-terminating and able to be terminated by ground command, is needed.

ID:

4066
Ground Calibration

ID:
4067
　　　Full instrument calibration is required before launch. NIST assets will be brought to bear as appropriate.

ID:
4069
The energy-dependent responses and the directional responses of the instruments shall be determined for energies ranging from the detector's low-energy threshold to energies for which the particle flux is below the instrument detection threshold, assuming particle flux levels given by the specified maximum particle fluxes.

ID:
4070
Discussion: Calibration can be performed by using a combination of accelerators and/or nuclear sources.

ID:
4071
Contaminants

ID:
4072
The response of the data channels to particles out-of aperture or of a different species or energy shall be less than 10% of the in-band particles.

ID:
4073
Correction algorithms for out-of-band response may be provided if necessary to comply with the out of band response requirement.

ID:
4074
Radiation damage

ID:
4075
Steps shall be taken to minimize and/or mitigate the effects of radiation damage on the instrument system during the lifetime.

ID:
5781

GOES Magnetospheric Particle Sensor Requirements (after removal of goals reflecting reduced Formulation / Risk Reduction Phase)

Observational parameter		Requirement
Low energy electrons and protons	Measurement range	Electrons and Protons: 30 eV - 30 keV
	Number of energy bands	Threshold: 15 evenly spaced logarithmic bands
	Measurement accuracy	Threshold: 25%, Goal: 10%
	Spatial coverage	Threshold: 5 directions; invariant under yaw flip
	Refresh rate	Threshold: 30 sec
	Minimum Flux	E is the energy in keV Electrons: Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}] = 9. \times 10^4 E^{-1.3}$ Protons: Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}] = 40. E^{-0.8}$
	Maximum Flux	E is the energy in keV Electrons: Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}] = 1.5 \times 10^9 E^{-1.3}$ Protons: Flux $[cm-2 s-1 sr-1 keV-1] = 1.1 \times 10^7 E^{-0.8}$
	Data Latency	1 min
Medium and high energy electrons and protons	Measurement range	Electrons: 30 keV - 4 MeV, Protons: 30 keV - 1 MeV
	Number of energy bands	Threshold: Electrons: 10 evenly spaced logarithmic bands plus 1 integral channel (>2 MeV), Protons: 7 evenly spaced logarithmic bands.
	Measurement accuracy	Threshold: 25%, Goal: 10%
	Spatial coverage	Threshold: 5 directions; invariant under yaw flip
	Refresh rate	Threshold: 30 sec
	Minimum Flux	E is the energy in keV Electrons: Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}] = 1.2 \times 10^7 E^{-2.8}$ Protons: Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}] = 8. \times 10^2 E^{-1.8}$
	Maximum Flux	E is the energy in keV Electrons: Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}] = 2.3 \times 10^{11} E^{-2.8}$ Protons: Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}] = 5 \times 10^7 E^{-1.3}$
	Data latency	1 min

ID:
4085

2.10.4.2.1 GOES Solar and Galactic Proton Sensor Requirements

Observational parameter	Requirement
Measurement range	Threshold: 1 MeV - 500 MeV Goal: 1 MeV - 500 MeV, and >500 MeV (see bands)
Number of energy bands	Threshold: 10 evenly spaced logarithmic bands , Goal: 10 evenly spaced logarithmic bands plus one integral for > 500 MeV
Measurement accuracy	Threshold: 25%, Goal: 10%
Spatial coverage	2 directions; direction of spacecraft velocity vector and anti-direction of spacecraft velocity vector
Refresh rate	Threshold: 1 min
Data latency	1 min
Maximum flux (E in keV)	Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}]$ $= 2. \times 10^{12} E^{-2.8}$
Minimum flux (E in keV)	Flux $[cm^{-2} s^{-1} sr^{-1} keV^{-1}]$ $= 8. \times 10^{2} E^{-1.8}$

ID:
4114

2.10.4.2.1.1 GOES Energetic Heavy Ion Sensor Requirements

Observational parameter	Requirement
Measurement range	10 MeV/nucleon - 200 MeV/nucleon, 4 mass groups: He, C-N-O, Ne-S, and Fe
Number of energy bands	Threshold: 5 evenly spaced logarithmic bands
Measurement accuracy	Threshold: 25%, Goal: 10%
Spatial coverage	1 direction (TBS); anti-nadir
Refresh rate	5 min (Consecutive measurements may be summed for more massive species)
Data latency	5 min
Maximum flux	Flux $[cm^{-2} s^{-1} sr^{-1} (MeV/nuc)^{-1}] = 5 \times 10^{4}$ $(E/nuc)^{-2.3}$ (E in MeV)
Minimum flux	Threshold: Flux $[cm^{-2} s^{-1} sr^{-1} (MeV/nuc)^{-1}] = 1.1 \times 10^{-2}$ $(E/nuc)^{-1}$ Goal: Flux $[cm^{-2} s^{-1} sr^{-1} (MeV/nuc)^{-1}] = 2.7 \times 10^{-3}$ $(E/nuc)^{-1}$

ID:
4143

2.10.4.3 X-Ray Sensor (XRS)

ID:
4144
The XRS shall detect the beginning, duration, and magnitude of solar X-ray flares.

ID:
4145
Discussion: The primary function of the XRS is to provide a means of detecting the beginning, duration, and magnitude of solar X-ray flares.

ID:
4146
The XRS shall monitor the disk (40 armin)-integrated solar flux as described in the GOES Solar X-ray Sensor Requirements Table below.

ID:
4147
Discussion: X-ray flares affect HF communications at Earth and are a key indicator of potential geoeffective solar activity. Detected solar flares are classified according to their peak fluxes in the 0.1 - 0.8 nm channel: class C, M, and X corresponds to peak fluxes of 1, 10, and 100×10^{-6} W m^{-2}, respectively.

ID:
4148
The instrument shall be sensitive enough to permit quiet sun background measurements at low levels of solar activity while detecting events at the lowest practicable threshold for early event warning.

ID:
4149
The observational parameters and requirements for the XRS, listed in the GOES Solar X-ray Sensor Requirements Table, shall be met.

ID:
4150
The minimum performance of the XRS shall not be compromised by the presence of the anticipated worst-case natural electron environment.

ID:
4151
The out-of-band rejection shall be such that < 10% of the observed signal comes from out-of-band, or some method of monitoring the out-of-band signal shall be provided.

ID:
5990

The signal level shall be such that at minimum (threshold) flux levels, the mean signal shall be greater than the standard deviation of the data (instrumental noise) over a 10-minute interval.

ID:
6352
The instrument responsivity of the XRS across its FOV shall be uniform to within +/- 5% (threshold) and 2% (goal).

Traceability to NIST standards will be verified and assurances of the claims of traceability will be exercised.

ID:
4152

ID:
4154

2.10.4.3.1 GOES Solar X-ray Sensor Requirements

Observational parameter	Requirement
Spectral range	0.05 - 0.8 nm
Number of channels	2, XRS-A: 0.05 - 0.4 nm XRS-B: 0.1 - 0.8 nm
Measurement range	Threshold: XRS-A: 5×10^{-9} - 5×10^{-4} W m^{-2} XRS-B: 2×10^{-8} - 2×10^{-3} W m^{-2} Goal: XRS-A: 1×10^{-9} - 1×10^{-3} W m^{-2} XRS-B: 1×10^{-8} - 4×10^{-3} W m^{-2}
Flux Resolution	Threshold: +/- 2%, Goal: +/- 1%
Measurement accuracy	Threshold: 10%, Goal: 5%
Spatial coverage	Solar disk (40 arcmin)
Pointing Knowledge	+/- 2 arcmin
Refresh rate	Threshold: 3 sec, Goal: 0.5 sec
Data latency	3 sec
Long-term stability	< 5% over mission duration
Continuity	No gaps

Wavelength Knowledge	+ / - 5% (prior to launch)

ID:
4195

2.10.4.4 Extreme Ultraviolet Sensor (EUVS)

ID:
4196

The EUVS shall monitor the solar EUV flux in the 5 - 127 nm range.

ID:
6068
Long term stability of the instrument measuring the EUV flux over the life of the mission shall not exceed the numbers in the table below.

ID:
4197
Discussion: Solar variability at these wavelengths is one of the primary drivers of thermospheric/ionospheric variability, which in turn affects radio communication, navigation, and satellite drag. Uncertainties in the solar EUV flux are a major source of errors in specification and modeling of the thermosphere and ionosphere.

ID:
4198
The observational parameters and requirements for the EUVS, listed in the GOES Solar EUV Sensor Observational Requirements Table, shall be met.

ID:
4199
The minimum performance of the EUVS shall not be compromised by the presence of the anticipated worst-case natural electron environment.

ID:
4200
The out-of-band rejection shall be such that < 10% of the observed signal comes from out-of-band. If the out of band signal is >10%, then a means of measuring and tracking this out of band signal shall be provided.

ID:
6351
The instrument responsivity of the EUVS across its FOV shall be uniform to within +/- 5% (threshold) and 2% (goal).

ID:
4201

ID:
6046

Full instrument calibration is required before launch. NIST assets will be brought to bear as appropriate.

ID:
4202

.

ID:
4203

2.10.4.4.1 GOES Solar EUV Sensor Observational Requirements

Observational parameter	Requirement
Spectral range	5 - 127 nm
Spectral Resolution	
From 5 to 35 nm	10 nm
From 35 to 115 nm	40 nm
From 118 to 127 nm	10 nm
Flux Resolution	0.25%
Minimum Flux	0.1x solar minimum
Maximum Flux	10x solar maximum
Measurement accuracy	Threshold: 10%, Goal: 5%
Spatial coverage	Solar disk (40 arcmin)
Pointing Knowledge	+/- 2 arcmin
Refresh rate	Threshold: 30 sec, Goal: 10 sec
Data latency	Threshold: 30 sec, Goal: 10 sec
Long-term stability	Threshold: < 5% over mission, Goal: < 2% over mission
Wavelength Knowledge	specified to +/- 5%
Continuity	No gaps

ID:
4241

2.10.4.5 Solar X-Ray Imager (SXI)

ID:
4242
The SXI shall provide a broadband imaging in the soft X-ray to EUV wavelength range.

ID:
4243
The SXI shall provide full-disk solar images at high cadence.

ID:

4244

Discussion: Available combinations of exposures and filters allows the autonomous coverage of the entire dynamic range of solar X-ray features, from coronal holes to X-class flares, as well as the estimate of temperature and emission measure. The operational goals are to: locate coronal holes for geomagnetic storm forecasts, detect and locate flares for forecasts of solar energetic particle (SEP) events related to flares, monitor changes in the corona that indicate coronal mass ejections (CMEs), detect active regions beyond east limb for F10.7 forecasts, and analyze active region complexity for flare forecasts.

ID:
4245

The observational parameters and requirements for the SXI, listed in the GOES Solar X-ray Imager Observational Requirements Table, shall be met.

ID:
4246

Discussion: Because improved capabilities are under discussion for this instrument compared to the original SXI, it has been called Extended SXI (ESXI)

ID:
6009

The SXI shall enable the retrieval of the Differential Emission Measure (DEM) as specified in the table below.

ID:
6010

Model Differential Emission Measures for Solar Features (See Note)

			Coronal Hole		Quiet Corona		Active Region		Flare	
		T	DEM	Error	DEM	Error	DEM	Error	DEM	Error
		5.5	20.29	±0.342	20.30	±0.342	20.50	±0.342	21.70	±0.342
		5.6	20.33	±0.301	20.20	±0.301	20.40	±0.301	21.70	±0.301
O bj ec ti ve		5.7	20.36	±0.255	20.20	±0.255	20.40	±0.255	21.70	±0.255
		5.8	20.36	±0.204	20.30	±0.204	20.50	±0.204	21.70	±0.204
		5.9	20.32	±0.146	20.40	±0.146	20.60	±0.146	21.75	±0.146
	T hr es h ol d	6.0	20.28	±0.146	20.70	±0.079	20.80	±0.079	21.80	±0.079
		6.1	20.20	±0.146	20.90	±0.079	21.00	±0.079	21.90	±0.079
		6.2	20.00	±0.146	20.80	±0.079	21.20	±0.079	22.00	±0.079
		6.3	19.70	±0.204	20.50	±0.079	21.30	±0.079	22.10	±0.079

6.4	19.20	±0.255	20.10	±0.079	21.30	±0.079	22.25	±0.079
6.5	18.50	±0.301	19.70	±0.146	21.10	±0.079	22.40	±0.079
6.6	N/A	N/A	19.20	±0.204	20.80	±0.079	22.55	±0.079
6.7	N/A	N/A	18.60	±0.255	20.30	±01.46	22.70	±0.079
6.8	N/A	N/A	N/A	N/A	19.50	±0.204	22.95	±0.079
6.9	N/A	N/A	N/A	N/A	18.50	±0.255	23.15	±0.079
7.0	N/A	N/A	N/A	N/A	N/A	N/A	23.20	±0.079
7.1	N/A	N/A	N/A	N/A	N/A	N/A	23.15	±0.146
7.2	N/A	N/A	N/A	N/A	N/A	N/A	22.95	±0.204
7.3	N/A	N/A	N/A	N/A	N/A	N/A	22.65	±0.255
7.4	N/A	N/A	N/A	N/A	N/A	N/A	22.10	±0.301
7.5	N/A	N/A	N/A	N/A	N/A	N/A	21.50	±0.342

Note: Base 10 logarithmic values of parameters are given.

DEFINITIONS:

Temperature

Temperature is defined in Kelvin. The Table gives the base 10 logarithmic value of the temperature grid for DEM evaluation. The grid is evenly spaced in the logarithmic domain. The threshold range covers T = 1 to 10 MK ($\text{Log}_{10}(T)$=6.0 to 7.0). The goal range covers from T = 0.5 to 20 MK ($\text{Log}_{10}(T)$=5.7 to 7.3). Grid bins may be considered to be evenly spaced in the logarithmic domain, e.g., the bin centered on $\text{Log}_{10}(T)$=6.5 would begin at $\text{Log}_{10}(T)$=6.45 and end at $\text{Log}_{10}(T)$=6.55.

Differential Emission Measure

The differential emission measure used here is the column emission measure per unit temperature as defined by:

$$DEM_C = \int \frac{n_e^2}{dT} dx$$

where n_e^2 is the electron number density in units of cm^{-3}, dT is the temperature differential in units of Kelvin (K), x is the line of sight integration path in units of cm. Thus, DEM_C has units of cm^{-5}-K^{-1}. Integration of DEM_C over temperature yields the column emission measure. The Table gives the base 10 logarithmic value of the DEM_C to be evaluated on the temperature grid given.

Error

The error allowable in the final retrieval of DEM information is per pixel and is defined in terms of a multiplicative error factor, e.g., a 20% error represents an error factor of 1.2. The base 10 logarithm of this error factor is given in the Table. For an error factor of 1.2, we have $\text{Log}_{10}(\text{Error})$=0.079, which is *additive* in the logarithmic domain. For example, if $\text{Log}_{10}(DEM_C)$=21.5 ±0.146, then the uncertainty of the final DEM determination is allowed to range from $\text{Log}_{10}(DEM_C)$=21.354 to 21.646.

The plasma DEM and temperature are related to the radiance, R, as follows:

$$R = \frac{1}{4\pi} \int_T \int_l DEM_C(T)F(l,T)dTdl$$

where F is the (photon) spectral emissivity per electron (cm^3 Å^{-1} s^{-1}). Thus, radiance is in units of cm^{-2} sr^{-1} s^{-1}. This can also be expressed as cm^{-2} arcsec^{-2} s^{-1}, in which case the incident photon rate on an SXI detector pixel, I_{pix}, would be computed as:

$$I_{pix} = \frac{\Omega}{4p} \int_T \int_l DEM_C(T)F(l,T)A_{eff}(l)dTdl$$

where Ω is the solid angle subtended by a detector pixel and A_{eff} is the instrument effective area as a function of wavelength. The units of the incident photons are counts per second. With the TBS spectral model, the above equations can be represented in terms of energy (ergs) rather than photons (counts).

Different technical approaches are possible such as the two examples described below. Option A represents a possible set of broad, soft X-ray bands. Option B represents a set of narrow, extreme ultraviolet bands. Bands for each option are provided in the following table.

Potential Spectral Bands

Band	Option A		Option B	
	Approximate Wavelength (nm)	Peak Response Log(T)	Wavelength (nm)	Approx. Peak Response Log(T)
A	0.6-10.0 nm	6.3	17.45 (Fe X)	5.9
B	0.6-8.0 nm	6.4	21.10 (Fe XIV)	6.3
C	0.6-5.0 nm	6.5	33.50 (Fe XVI)	6.5
D	0.6-2.0 nm	6.7	9.40 (Fe XVIII)	6.9
E	0.6-1.6 nm	6.8	19.30 (Fe XII & XXIV)	6.1 & 7.5
F	0.6-1.2 nm	7.0	13.10 (Fe VIII & XX)	5.7 & 7.2

The temperature response of Option A is broad while the temperature response of Option B is narrow. Thus, while the peak response of Option A may not be at LogT=6.0, substantial response still exists at that temperature.

The selected bands and response shall allow the reconstruction of DEM curves shown above, modeled for different solar features, to be accomplished from LogT=5.7 to LogT=7.2 with the uncertainties specified. DEM reconstruction will be accomplished using the hybrid abundances of Fludra and Schmelz (The absolute coronal abundances of sulfur, calcium, and iron from Yohkoh-BCS flare spectra, *Astronomy and Astrophysics*, *348*, 286-294, 1999), the ionization equilibrium of Mazzotta et al. (Ionization balance for optically thin plasmas: Rate coefficients for all atoms and ions of the elements H to NI, *Astronomy and Astrophysics Supplement Series*, *133*, 403-409, 1998), and the TBS spectral model. If one of the two examples above is not employed, DEM reconstruction uncertainties shall be computed using Monte Carlo simulation with a noise model of appropriate fidelity, e.g. including photon statistics, detector read noise, etc. An appropriate curve-fitting algorithm (TBS) will be used to obtain a smooth DEM reconstruction.

ID:
4247

2.10.4.5.1 GOES Solar X-ray Imager Observational Requirements

Observational parameter	Requirement

Spatial coverage	0 - 1.3 solar radii
Spatial/Angular resolution	See next table (below)
Pointing/"Mapping" accuracy	Stability during 24 hours: +/- 1.0 arcmin (N-S, E-W), Stability during exposure: +/- 2.0 arcsec (E-W) (THRESHOLD) and +/- 2.0 arcsec (N-S) (THRESHOLD) and +/- 1.0 arcsec (E-W) (GOAL) and +/- 1.0 arcsec (N-S) (GOAL) Control: +/- 15.0 arcsec +/- 3 arcmin of sun center
Pointing Knowledge / Mapping uncertainty	+/- 2.5 arcsec
Measurement range	Threshold: Radiance: 0.3 - 106 (TBR) photons s^{-1} cm^{-2} $arcsec^{-2}$ Temperature: 1 - 10 MK (TBS); Goal: Radiance: 0.3 - 10^6 photons s^{-1} cm^{-2} $arcsec^{-2}$ Temperature: 0.5 - 20 MK (TBS)
Measurement resolution	Threshold: Radiance: 0.1% (TBS) Goal: Radiance: 0.1%, (TBS)
Measurement accuracy	Threshold: 20% in radiance, Goal: 10% in radiance
Refresh rate	Threshold: Imaging: < 2 min, Temperature: < 6 min Goal: Imaging: < 1 min, Temperature: < 3 min
Product latency*	< 1 min
Long-term stability	20%
Reliability/Continuity	No gaps > 2 min

ID:
6018
* Product latency is defined as the time from the end of data collection to the end of product generation. Forty seconds of the latency is required for processing the data at SEC.

ID:
6011
The SXI shall meet the spatial resolution requirements of the following table. The point response shall be uniform to ±30% across the entire field of view (THRESHOLD). As a GOAL, the point response shall be uniform to ±10%.

ID:
6012
Point Response Requirement in Terms of Encircled Energy

Encircled Energy	Threshold Diameter (arc sec)	Goal Diameter (arc sec)
37%	7	5
66%	14	10

75%	21	15
85%	35	25
99% (TBS)	56	40

ID:
6013
Discussion: The spatial/angular resolution is has been written in terms of the encircled energy requirement.

ID:
4291
Discussion: Refresh rate for 'imaging' refers to full measurement range coverage in a single bandpass filter. This may consist of multiple images with different exposures. Refresh rate for temperature assumes that full measurement range data in at least three bandpass filters is required for temperature retrieval.

ID:
4292
Spacecraft Housekeeping data shall be supplied in real time in conjunction with the SXI data.

ID:
4293
Discussion: Examples include flagging spacecraft or other instrument operations that adversely affect SXI performance such as blackbody calibration and calibration of other instruments.

ID:
4294
Time tagging of SXI data shall be synchronized with Universal Time within 1.0 msec.

ID:
4295
Discussion: SXI images should be taken at a regular cadence with a phase drift of no more than 1.0 second per day. The need to precisely phase SXI images should not preclude the ability to simply take images at a faster or slower pace. Images must be downlinked in the order taken.

ID:
6047
Full instrument calibration is required before launch. NIST assets will be brought to bear as appropriate.

ID:
4296

2.10.4.6 Solar coronagraph (SCOR)

ID:
4297
This instrument is currently envisioned as a part of pre-planned product improvement (P^{3}I).

ID:
4298
The SCOR shall provide white light imagery of the inner corona at a high cadence, with the aim of determining the speed, direction, and spatial extent of detected CMEs.

ID:
4299
Discussion: The primary function of the Solar CORonagraph (SCOR) is early detection of coronal mass ejections (CMEs). CMEs are one of two main drivers of geomagnetic storms and the main driver of the largest storms. The coronagraph will provide one to three day warnings of geomagnetic storms.

ID:
4300
The observational parameters and requirements for the coronagraph, listed in the GOES Solar Coronagraph Observational Requirements Table, shall be met.

ID:
4301
Note: The instrument passband will be chosen to lie within the listed spectral range.

ID:
4302

2.10.4.6.1 GOES Solar Coronagraph Observational Requirements

Spectral band	5000 - 8000 Å (TBD, see note above).
Spatial coverage	Threshold: 3.7 - 17 solar radii (0.93 - 4.25 deg halfwidth), Position angle: > 355 deg Goal: 2 - 17 solar radii (0.5 - 4.25 deg halfwidth), Position angle: 360 deg
Spatial resolution	50 arcsec (TBS)
Pointing accuracy	+/- 1 arcmin of sun center
Mapping accuracy / Pointing stability	6.25 arcsec during image sequence (TBS) (Note this value varies with spatial resolution).
Mapping uncertainty / Pointing Knowledge	Threshold: 25 arcsec, Goal: 12.5 arcsec (TBS)
Measurement range	Threshold: 1×10^{-11} - 1×10^{-8} B/B_{Sun} (TBS), where Bsun is the mean solar brightness. Goal: 1×10^{-11} - 5×10^{-8} B/B_{Sun} (TBS), where Bsun is the mean solar brightness.

Measurement resolution	Threshold: 5×10^{-11} B/B$_{Sun}$ inner, 1×10^{-12} B/B$_{Sun}$ outer, where B$_{sun}$ is the mean solar brightness Goal: 1×10^{-11} B/B$_{Sun}$ inner, 1×10^{-12} B/B$_{Sun}$ outer, where B$_{sun}$ is the mean solar brightness
Measurement accuracy	Threshold: 25%, Goal: 10%
Refresh rate	15 min
Product latency*	7 min (Threshold), 2 minute (Goal)
Stray Light	Threshold: 5×10^{-12} B/B$_{sun}$ Goal: 1×10^{-12} B/B$_{sun}$
Reliability/Continuity	Threshold: No gaps > 30 min, Goal: No gaps

ID:
4340
* Product latency is defined as the time from the end of data collection to the end of product generation. Forty seconds of the latency is required for processing the data at SEC.

ID:
6048
Full instrument calibration is required before launch. NIST assets will be brought to bear as appropriate.

ID:
6014

ID:
4341

2.10.5 Remaining Spacecraft Resources

ID:
4342
Any remaining space in the satellite that fits into the remaining spacecraft allocations, after all of the other instruments and communications are accommodated, will be allocated to additional P^{3}I resources.

ID:
4343

2.10.6 GOES Lightning Mapper (GLM)

ID:
4344
The GOES Lightning Mapper (GLM) is now classified as an operational instrument.

ID:
4345

The GLM will meet the following GPRD-1 requirement (the MRD requirement follows this paragraph listed for traceability):

ID:
4346
The GLM shall map all forms of lightning discharges over the hemisphere, CONUS, and mesoscale with the following requirements: 10 km horizontal spatial resolution (THRESHOLD) and 0.5 km (GOAL); vertical resolution from the surface to the cloud top; with 5 km mapping accuracy (THRESHOLD) and a 0.100 km (GOAL); with real time measurements range; 70-90% probably of detection (THRESHOLD) with 99% (GOAL); with continuous refresh; and 1 minute latency (THRESHOLD) or 10 sec (GOAL) latency to the level 1 b product.

ID:
4347
General comments

ID:
4348
A GOES Lightning Mapper will be a new tool for NOAA. In addition to the nowcasting component, the data would be assimilated into models. It would have the potential to increase tornado warning lead times, improve lightning danger alerts by providing information on storm intensification, and enable disaster teams to be ready and on site sooner. Better lightning detection would provide economic benefits for airplane safety, passenger comfort, and route optimization. A long-term database of lightning data strikes would provide information on lightning to track any decadal changes. *
The lightning measurements will be related on a continuous basis to other observable data, such as radar returns, cloud images, and other meteorological variables.

ID:
4349
GLM requirements

ID:
4350
The GLM shall continuously detect lightning over the full disk view of the earth as seen from the satellite location. The full disk covers nominally 17.76 degrees, with the exception of limb darkening effects. The full disk includes the CONUS and the mesoscale.

ID:
4351
Discussion: Lightning must be detected from all of the areas listed above all of the time, not by scanning the entire full disk area and sampling only a portion of it at one time and another portion at a later time.

ID:
4352
The spatial resolution shall be 10 km (THRESHOLD) with a 0.5 km (GOAL) at the satellite sub point (SSP).

ID:

4353

Discussion: Lightning will illuminate the entire cloud but there is a need to sample at a 4 km spatial resolution in order to better identify the location of the storm cells.*

ID:

4354

Lightning shall be detected over a vertical range from the surface to the cloud top. This shall include detection of lightning in the vertical column.

ID:

4355

Discussion: Distinguishing between the various types of lightning (cloud-to-ground versus cloud-to-cloud) is not required.

ID:

4356

The navigation error shall be less than 1/2 of the angular equivalent of the horizontal spatial resolution (TBR) (THRESHOLD) with a < 6 urad (TBR) (GOAL).

ID:

4357

The frame to frame registration error shall be less than or equal to 0.5*spatial resolution (TBR) (THRESHOLD). The goal for this quantity shall be less than or equal to 0.25*spatial resolution (TBR) over 1 second.

ID:

4358

The probability of flash detection shall be 70 % (THRESHOLD) and 99% (GOAL).

ID:

4359

The data must be delivered in TBS seconds to the ground to allow for all processing to be completed to meet the 1 minute latency to the level 1b.

ID:

4360

The GLM shall detect lightning flashes, which can occur with a 1ms duration.

ID:

6066

Full instrument calibration is required before launch. NIST assets will brought to bear as appropriate

ID:

2.10.7 Geo-Microwave

ID:
4362
The GOES Microwave Imager/Sounder (GEM or GMS) is currently planned as pre-planned product improvement (P^{3}I) See section 2.11.4 for that definition. **The microwave instrument will perform the following measurements required by the GPRD-1. Goal values are currently listed in Appendix A.**

ID:
4363
The microwave instrument will *measure* the **Vertical Temperature profile** through the clouds. The spatial resolution will be reduced from that of the infrared sounder (see section (2.10.2) 2A). The following details the requirement for **Vertical Temperature profile** through the clouds: 10 km spatial resolution; with Sfc-500 mb: 300-500 m, 500-300 mb: 1-2 km, 300-100 mb: 1-2 km, 100 mb and above: 2-3 km vertical resolution; over the range of 210-320 K, with an accuracy of +/- 1 K/km, 60 min refresh rate, 2 km mapping accuracy, and TBD data latency need.

ID:
4364
The microwave instrument will *measure* the **Vertical Moisture profile** through the clouds. The spatial resolution will be reduced from that of the infrared sounder (see section (2.10.2) 2A). The following details the requirement for **Vertical Moisture profile** through the clouds: 10 km spatial resolution; with surface-500 mb: 300-500 m, 500-300 mb: 1-2 km, 300-100 mb: 1-2 km vertical resolution; over the range of 0 - 100 %, with an accuracy of surface-500 mb of 10 %, 500-300 mb of 10%, 300-100 mb of 20%; 60 min refresh rate; 2 km mapping accuracy; and TBD data latency need.

ID:
4365
The microwave instrument will *measure* the **Capping Inversion profile** through the clouds. The spatial resolution will be reduced from that of the infrared sounder (see section (2.10.2) 2A). The following details the requirement for **Capping Inversion profile** through the clouds: 10 km spatial resolution, with Sfc-500 mb: 300-500 m vertical resolution, over the range of T:210-300K and Td:210-300K and height: surface-650mb, with an accuracy of T: 10K, Td: 10K, and Hgt:150-250 mb; 15 min refresh rate, 2 km mapping accuracy, and TBD data latency need.

ID:
4366
The microwave instrument will *measure* the **Moisture Flux** profile through the clouds. The spatial resolution will be reduced from that of the infrared sounder (see section (2.10.2) 2A). The following details the requirement for **Moisture Flux** profiles through the clouds: 4 km spatial resolution, with 3 km vertical resolution, over the range of 0 - 20 g/kg/h, with an accuracy of 10 %, 60 min refresh rate, 1 km mapping accuracy, and TBD data latency need.

ID:

4367

The microwave instrument will *contribute to* the **Imagery, All Weather, Day and Night** of ABI and HES. The spatial resolution will be reduced from that of the infrared imager and the infrared sounder. The following details the requirement for **Imagery, All Weather, Day and Night:** 4 km spatial resolution, with 3 km vertical resolution, over the range of 0 - 20 g/kg/h, with an accuracy of 10%, 60 min refresh rate, 1 km mapping accuracy, and TBD data latency need.

ID:

4368

The microwave instrument will *contribute to* **Hail Detection** over the Hemisphere, CONUS, and Mesoscale but at degraded spatial resolution. The following details the requirement for **Hail Detection:** 2 km spatial resolution, with TBD vertical resolution, over the range of TBD, with an accuracy of TBD, 5 min refresh rate, 0.5 km mapping accuracy, and TBD data latency need.

ID:

4369

The microwave instrument will *contribute to* **Precipitation Type and Rate** over the Hemisphere, CONUS, and Mesoscale but at degraded spatial resolution. The following details the requirement for **Precipitation Type and Rate:** 0.5 km spatial resolution, with TBD vertical resolution, over the range of 0-100 mm/hr, with an accuracy of 1 mm/hr, 30 min refresh rate, 1 km mapping accuracy, and TBD data latency need.

ID:

5841

The microwave instrument will *contribute to* **Rainfall Potential** over the Full Disk but at degraded spatial resolution. The following details the requirement for **Rainfall Potential**: 2 km spatial resolution, with TBD vertical resolution, over the range of 0-100 mm/hr, with an accuracy of 5 mm/hr, 15 min refresh rate, 1.0 km mapping accuracy, and 5 min data latency need.

ID:

4370

The microwave instrument will *measure* the **Total Water Content.** The GMS will contribute be 100 km (THRESHOLD) on the Hemisphere, 25 km on the CONUS (THRESHOLD), and 25 km on the mesosphere (THRESHOLD). The following details the requirement for **Total Water Content:** over a measurement range of 0-100 mm with a measurement accuracy of 1 mm; and a coverage time of 3 hours for the hemisphere, 1 hour for CONUS, and 15 minutes for the mesoscale. The data latency will be 60 minutes for the hemisphere, 10 minutes for CONUS, and 10 minutes for the mesoscale.

ID:

4371

The microwave instrument will measure the **Tropical Cyclone Inner Core Vertical Temperature Profile.** The following details the threshold requirement for the **Tropical Cyclone Inner Core Vertical Temperature Profile:** over the full disk and hemisphere, with a threshold 60 minute refresh; with a 3 minute threshold latency; at 10 km threshold resolution; using the temperature sounding; using 2 km mapping uncertainty; over the range of 210 to greater than 300 K, with surface to 100 mb and above vertical resolution; and with +/- 1 K precision.

ID:
4372

The microwave instrument will measure **Sea Surface Winds** through a polarization measurement to address the following details of the threshold requirement for the **Sea Surface Winds** determination: over the full disk and hemisphere, with a threshold 60 minute refresh, with a 3 minute threshold latency, at 10 km threshold resolution by using the moisture and temperature sounding of 10 , using 0.5 km mapping uncertainty for ABI, and over the range of 0 - 150 knots, and with +/- 5 knots accuracy.

ID:
5840

The microwave instrument will measure **Sea Surface Winds: Mesoscale** through a polarization measurement to address the following details of the threshold requirement for the **Sea Surface Winds** determination: over the 1000 km by 1000 km mesoscale with a threshold 60 minute refresh, with a 15 minute threshold latency, at 10 km threshold resolution (TBR) by using the moisture and temperature sounding vertical resolution of 10 km , using 5.0 km mapping uncertainty for ABI, and over the range of 0 - 50 m/sec, and with +/- 1 m/sec accuracy.

ID:
4373

The microwave instrument will *contribute* to **Coastal Sea Surface Winds** (inside the EEZ) to address the following details of the threshold requirement for the **Coastal Sea Surface Winds** (inside the EEZ); with a threshold 60-minute refresh, a 3-minute latency, at 10.0 km. threshold resolution, using TBD km mapping uncertainty, over the ranges of 0 to 150 knots, with +/- 1-knot accuracy.

ID:
4374

The GOES Microwave Sensor (GMS) will have one of several forms. A 6 band, multi-channel radiometer is described here. A phased array similar to the GEOStar array of JPL (a 3 band instrument) and other forms of the microwave instruments are also being considered. The requirements for the six-band radiometer are described here, although other types of coverage are not excluded. As described in Section (2.10.2) 3.B.2.g of the HES, temperature and water vapor information can be obtained from several spectral regions of the atmosphere in the infrared and several examples are listed in that section. In a parallel sense, the band coverage listed below is an example of microwave spectral coverage that then can yield temperature and water vapor retrievals, in combination with clear window coverage.

ID:
4375

The GMS will provide time-resolved precipitation imagery and atmospheric vertical temperature and water vapor profiles through many types of cloud cover. The instrument, defined by the table below, uses frequencies from 50 GHz through 425 GHz to provide equatorial horizontal spatial resolution (after post-processing) of ~12 km.

ID:
4376
Parabolic Microwave radiometer

ID:
4377
A baseline design for GMS employs a 2-m reflector in a symmetric Cassegrain configuration with a small (~15 cm) scanning subreflector. The subreflector is capable of rapid angular rotation to effect a small amount of beam scan, along with translation to compensate for changes in focal length of the main reflector due to temperature induced distortions. Receivers are located behind the main reflector and use a third reflector (also behind the main reflector) that rotates to permit the receivers to view either the Earth (via the main reflector), one of two warm calibration targets, or cold space (also for calibration).

ID:
4378
Based on estimates for receiver performance, the scan time for an approximate CONUS area (3000 km x 5000 km) is 90 minutes. For regional areas (1500 km x1500 km) the scan time decreases to ~15 minutes. The overall scan time is anticipated to decrease somewhat with expected improvements in receiver components.

ID:
6067
Full instrument calibration is required before launch. NIST assets will brought to bear as appropriate

ID:
4379

2.10.8 Communications

ID:
4380
Note: This section describes the space-located communication for the GOES-R system. The relocation of these services, other than telemetry and command, to a commercial satellite or a dedicated satellite is being considered.

ID:
4381

2.10.8.1 Satellite Services

ID:

4382

2.10.8.1.1 Telemetry and Command

ID:
4383
The GOES-R satellite is required to support telemetry and command of the spacecraft. This system interfaces with the terrestrial components described below:

ID:
4385

The NOAA Command and Data Acquisition Station (CDAS) and the backups described in section 3.3 and the associated NOAA Satellite Operations Control Center (SOCC) become the primary telemetry interface during normal on-orbit operation.

ID:
4384

The NASA Deep Space Network (DSN) or similar system: This interface is primary during the aunch and orbit raising phases of the mission.

ID:
4386
The spacecrafts described in the Space and Launch Segment shall support this capability.

ID:
4387

2.10.8.1.2 Sensor Data Downlink

ID:
4388
The Sensor Data (SD) link is a primary data link that includes all spacecraft components required for the downlink transmission of the combined (multiplexed) on-board instrument data to the NOAA Command and Data Acquisition Station (CDAS).

ID:
4389
The Sensor Data (SD) link provides for the transmission of all sensor data in a multiplexed format to the designated NOAA CDAS. This link shall have the following basic characteristics:

ID:
4390
Data Content   Instrument data from the ABI, HES, GMS (P^3I), GLM, SIS, SEISS, and SCOR (P^3I), and selected telemetry functions. Specific components depend on spacecraft:

ID:
4391

A Satellite: ABI, SIS, GLM

ID:
4392

B Satellite: HES, SEISS

ID:
4393

(P^{3}I), possibly C satellite: GMS, SCOR (SCOR location TBR)

ID:
4394

Data Rate   The multiplexed instrument data rate for the satellites are:

ID:
4395

A Satellite: 65 Mbit/s (approx., TBR)

ID:
4396

B Satellite: 67 Mbit/s (approx., TBR)

ID:
4397

(P^{3}I), possibly C satellite: ~ 2 Mbit/(approx., TBR)

ID:
4398

Data Format   Compatible with CCSDS recommendations

ID:
4399

Error Control   As applied by the C&DH subsystem

ID:
4400

Required BER $1 \cdot 10^{-9}$ at 99.9% link availability (threshold), worst month (TBR); $1 \cdot 10^{-10}$ at 99.9% link availability (goal), worst month (TBR)

ID:
4401

RF Bandwidth (See appendix B)

ID:
4402

      X-Band downlink (see appendix B for numeric bandwidths)

ID:
4424

Coverage	Primary and backup CDAS from 75º W, 90º W (check-out), 105º W (storage and operations (TBS)) and 135 (TBS)º W satellite. For GOES East (75º W) the primary CAD's is located at Wallops Island, VA with a backup at GSFC. For West (135º W (TBS)) the primary CDAS is located at Wallops Island, VA with a backup at Fairbanks, AK. For GOES-R Central (P^3I) (105º W) the primary and backup CDAS are TBS.

Discussion: It is relevant to note that Siberia has much more stringent PFD requirements than Alaska and this has to be considered in the design of the SD antenna beamshape.

ID:
4425
The spacecrafts described in the Space and Launch Segment shall support this capability.

ID:
4426

2.10.8.2 Removed

ID:
4427

2.10.8.3 Payload Services

ID:
4428

2.10.8.3.1 GOES Rebroadcast

ID:
4429
The GOES Re-Broadcast (GRB) transponder supports the processed data distribution from the CDAS to various receive sites including NOAA's NWS, DoD, international users, and research organizations.

ID:
4430

The GOES Re-Broadcast (GRB) transponder supports the rebroadcast of the ground processed weather data from the CDAS to a wide community of NWS and governmental and academic research organizations. This link shall have the following basic characteristics:

ID:
4431
Data Content   Ground processed sensor data similar in content to the current GVAR data (the data content is transparent to the GRB transponder)

ID:
4432

Data Rate   5 Mbit/s total (Threshold) including all overhead (TBR) and 24 Mbps
GOAL   (TBR) including all overhead.

Discussion: More information is available in Appendix B on the increase in available bandwidth to afford additional communication capability for GOES-R and specifically the GRB capacity.

ID:
4433

Data Format   TBD (the data format is transparent to the GRB transponder)

ID:
4434

Error Control TBD

ID:
4435

Required BER 1 x 10^{-6} (Threshold) and 1 x 10^{-8} (Goal) at 99.9% availability, worst month (TBR)

ID:
4436

RF Bandwidth (See appendix B) (TBR).

ID:
4437

RF Band   Uplink: S-Band (TBR, X-Band is being considered) (see appendix B for numeric band frequencies).

ID:
4438

                          Downlink: L-Band

ID:
4439

Coverage	Uplink: Primary and backup CDAS from 75º W, 90º W (check-out), 105º W (storage and operations (TBS)). For GOES-R East (75º W) the primary CDAS is located at Wallops Island, VA with a backup at GSFC. For GOES-R West (135º W (TBS)) the primary CDAS is located at Wallops Island, VA with a backup at Fairbanks AK. For GOES-R Central (P^{3}I) (105º W) the primary and backup CDAS are TBS.

ID:
4440

Downlink:	Earth Coverage to 5º-elevation angle

ID:
4441

The spacecraft described in the Space and Launch Segment shall support this capability.

Discussion: GRB potentially has a higher data rate than the GOES N-Q GVAR service due to the enhanced imagery and sounding capabilities of the GOES R series.

ID:
4442

2.10.8.3.2 Unique Payload Services

ID:
4443

2.10.8.3.2.1 Search and Rescue

ID:
4444

Support is provided to the Cospas-Sarsat System through an on-board Search and Rescue (SAR) transponder that relays received emergency beacon signals to Local User Terminals (LUTs) in the Sarsat system.

ID:
4445

GOES support of the Cospas-Sarsat Search and Rescue (SAR) is provided by an on-board transponder. The system requirements for the GOES-R series will be similar to that of the preceding GOES generations however the downlink to the Local User Terminals (LUT's) will be a direct frequency translation of the uplink band:

ID:
4446

Data Content	Data content is transparent to the transponder

ID:

4447

    Data Rate   Transmission is rate 400 bit/s (transponder does not remodulate)

    Data Format   Data format is transparent to the transponder

    Error Control As present on beacon signal

    Required BER $5 \cdot 10^{-5}$ at 99.9% availability, worst month (TBR)

    RF Bandwidth 100 kHz (approx., TBR)

    RF Bands   Uplink: UHF

                     Downlink: L-Band (see Appendix B)

    Coverage   Uplink: Earth Coverage to 5°-elevation angle

    Downlink: Earth Coverage to 5°-elevation angle

The spacecrafts described in the Space and Launch Segment will support this capability.

2.10.8.3.2.2 DCP

The Data Collection Platforms (DCP) in the Data Collection System (DC is a data link that provides a service. The DCS channel plays a significant role in supporting critical national systems important to the safety of citizens, commerce, shipping, and farming among other things. Data obtained from this service is also widely used by the National Weather Service. Support to the DCS is provided by two satellite transponders. The Data Collection Platform Report (DCPR) transponder supports the link from a large number of small data platforms in the DCS to the CDAS and other Direct Readout Ground Stations (DRGS). The Data Collection Platform Interrogate (DCPI) transponder supports a command link from the CDAS to selected platforms.

ID:
4459
Support to the Data Collection System (DCS) is provided by two satellite transponders. These correspond to (1) the links required for the Data Collection Platforms (DCP's) to provide reported data to the CDAS and other Direct Readout Ground Stations (DRGS) termed Data Collection Platform Report (DCPR) links and (2) an outbound polling link from the CDAS to the DCP's termed the Data Collection Platform Interrogate (DCPI) link.

ID:
6353
In the GOES-R timeframe, the anticipated 89,000 (TBS) total platforms (Threshold) shall be supported, with a goal of 158,000 supported platforms.

ID:
4460

> Discussion: DCS users project a large growth in usage, due to both more platforms and shorter report intervals. Additionally, the NWS estimates the value of DCS to be several billion dollars per year. These factors are likely to drive system loading near the capacity limits of the current DCPR system by the expected GOES R launch date.

ID:
4461

 2.10.8.3.2.2.1 Data Collection Platform Report (DCPR)

ID:
4462
The DCPR links originate at any of a large number of DCP's and are supported in the GOES-R satellite by a bent pipe transponder with the following basic interface characteristics. The signals in this transponder are in an FDMA format:

ID:
4463
Data Content   Data content is transparent to the transponder

ID:

4464

Data Rate　　　　　　Transmission rates of 100, 300, or 1200 bit/s, (transponder does not remodulate), although a small number of platforms require data rates as high as 128 kbps (TBR).

Discussion: Platforms with 100 bits/sec are anticipated to be decommission by 2012, which would leave only 300 or 1200 bite/sec platforms. Any 128 kbps platforms may not be supportable on this system without a significant disruption to the existing system.

ID:
4465

Data Format　　Data format is transparent to the transponder

ID:
4466

Error Control　The error control is transparent to the DCPR transponder

ID:
4467

Required BER $1 \cdot 10^{-6}$ at 99.9% availability, worst month (TBR) Threshold, $1 \cdot 10^{-7}$ at 99.9% availability, worst month (TBR) Goal

ID:
4468

RF Bandwidth　　　　　Channelized into 433 channels (400 @ 750 Hz and 33 @ 3 kHz) for a total bandwidth of 400 kHz.

ID:
4469

RF Bands　　Uplink:　　　UHF

ID:
4470

　　　　Downlink:　L-Band　(see Appendix B)

ID:
6355

Latency for final products: 5 min (threshold), 1 minute (goal)

ID:
4471

Coverage　　Uplink:　　　Earth Coverage to 5°-elevation angle

ID:
4472

　　　　　Downlink:　　Earth Coverage to 5°-elevation angle

ID:
4473
The spacecrafts described in the Space and Launch Segment shall support this capability.

ID:
6354
> Discussion: Typical platforms support 4 transmission per hour with typical message sizes of 200 -1000 Bytes. A small number of platforms require transmissions as frequently as every 5 minutes and have messages as large at 30 KBytes.

ID:
4474

  2.10.8.3.2.2.2 Data Collection Platform Interrogate (DCPI)

ID:
4475
Transmission of the DCPI links from the CDAS to the DCP's is supported in the GOES-R satellite by a bent pipe transponder that must have the following basic interface characteristics:

ID:
4476
> Data Content   Data content is transparent to the transponder

ID:
4477
> Data Rate   2400 bps (transponder does not remodulate)

ID:
4478
> Data Format   Data format is transparent to the transponder

ID:
4479
> Error Control   Forward Error Correction (TBS)

ID:
4480
> Required BER $1 \cdot 10^{-6}$ at 99.9% availability, worst month (TBR)

ID:
4481
> RF Bandwidth 100 kHz (at least, TBR)

ID:

4482

RF Bands   Uplink: S-Band

ID:
4483

Downlink: UHF

ID:
4484

Coverage   Uplink: Primary and backup CDAS from 75º W, 90º W (check-out), 105º W (storage and operations (TBS)). For GOES-R East (75º W) the primary CDAS is located at Wallops Island, VA with a backup at GSFC. For GOES-R West (135º W (TBS)) the primary CDAS is located at Wallops Island, VA with a backup at Fairbanks AK. For GOES-R Central (P^{3}I) (105º W) the primary and backup CDAS are TBS.

ID:
4485

Downlink: Earth Coverage to 5º-elevation angle

ID:
4486

The spacecraft described in the Space and Launch Segment shall support this capability.

ID:
4487

2.10.8.3.2.3 LRIT

ID:
4488

The Low Rate Information Transmission (LRIT) is an unique digital data link that provides a service. The LRIT transponder supports the transmission of low-resolution satellite imagery from the CDAS to a large number of small receiving sites. This service is an evolution of the existing WEFAX analog facsimile transmission.

ID:
4489

The Low Rate Information Transmission (LRIT) service supports the widespread distribution of relatively low data rate low-resolution satellite imagery from the CDAS to a large number of small receiving sites. Transmission is supported in the GOES-R satellite by a bent pipe transponder that must have the following basic interface characteristics:

ID:
4490

Data Content   Data content is transparent to the transponder

ID:
4491

     Data Rate   Information rate 256 kbit/s, Transmission rate 585 kbit/s (TBR) (transponder does not remodulate)

ID:
4492

     Data Format   Data format is transparent to the transponder

ID:
4493

    Error Control   TBS

ID:
4494

     Required BER $1 \cdot 10^{-8}$ at 99.9% availability, worst month (TBR)

ID:
4495

     RF Bandwidth   600 kHz (approx., TBR)

ID:
4496

    RF Bands   Uplink: S-Band

ID:
4497

     Downlink: L-Band (see Appendix B)

ID:
4498

   Coverage   Uplink: Primary and backup CDAS from 75º W, 90º W (check-out), 105º W (storage and operations (TBS)). For GOES-R East (75º W) the primary CDAS is located at Wallops Island, VA with a backup at GSFC. For GOES-R West (135º W (TBS)) the primary CDAS is located at Wallops Island, VA with a backup at Fairbanks AK. For GOES-R Central (P^3I) (105º W) the primary and backup CDAS are TBS.

ID:
4499

     Downlink: Earth Coverage to 5º-elevation angle

ID:
4500

The spacecrafts described in the Space and Launch Segment will support this capability.

ID:
4501

2.10.8.3.2.4 EMWIN

ID:
4502
The Emergency Managers Weather Information Network (EMWIN) is an unique data link that provides a service. The EMWIN transponder provides for the transmission of low data rate weather and other emergency related data from the CDAS to Local Emergency Managers of the Federal Emergency Management Agency (FEMA).

ID:
4503
The Emergency Managers Weather Information Network (EMWIN) service supports the widespread distribution of low data rate weather and other emergency related data from the CDAS to small receive only earth stations in the service of Local Emergency Managers of the Federal Emergency Management Agency (FEMA). Transmission is supported in the GOES-R satellite by a bent pipe transponder that must have the following basic interface characteristics:

ID:
4504
Data Content Data content is transparent to the transponder

ID:
4505
Data Rate   Information rate 56 kbit/s, Transmission rate is approximately 77 kbit/s (TBR) (transponder does not remodulate)

ID:
4506
Data Format   Data format is transparent to the transponder

ID:
4507
Error Control   TBS

ID:
4508
Required FER $1 \cdot 10^{-5}$ at 99.9% availability, worst month (TBR) (Note Frame Error Rate)

ID:
4509
RF Bandwidth   160 kHz (approx., TBR)

ID:
4510

     RF Bands   Uplink: S-Band

ID:
4511

                     Downlink: L-Band (see Appendix B)

ID:
4512

     Coverage   Uplink: Primary and backup CDAS from 75º W, 90º W (check-out), 105º W (storage and operations (TBS)). For GOES-R East (75º W) the primary CDAS is located at Wallops Island, VA with a backup at GSFC. For GOES-R West (135º W (TBS)) the primary CDAS is located at Wallops Island, VA with a backup at Fairbanks AK. For GOES-R Central (P³I) (105º W) the primary and backup CDAS are TBS.

ID:
4513

                     Downlink: Earth Coverage to 5º-elevation angle

ID:
4514

The spacecraft described in the Space and Launch Segment will support this capability.

ID:
6562

2.10.8.3.2.5 NOAA Ships Ocean Data Support

ID:
6563

A new service NOAA Ships Ocean Data Support (Ships) is needed to provide the instantaneous transmission of oceanographic, fisheries or hydrographic survey data collected on ships. This information shall be sent real-time to labs and processing centers on shore by this service. Currently there are at least eighteen ships.

ID:
6564

     Data content   Data content is transparent to the transponder.

ID:
6565

     Data rate: 9600 bps (THREHOLD) and 64 kbps (GOAL) per ship

ID:
6566

Data format   Data format is transparent to the transponder.

ID:
6567

Error Control   TBS

ID:
6568

Required BER $1 \cdot 10^{-6}$ at 99.9% availability (TBR), worst month

ID:
6569

RF Bandwidth   TBD

ID:
6570

RF Bands   Uplink: TBD

ID:
6571

           Downlink: TBD

ID:
6572

Coverage   Uplink: Primary and backup CDAS from 75º W, 90º W (check-out), 105º
W   (storage and operations (TBS)). For GOES-R East (75º W) the primary
CDAS   is located at Wallops Island, VA with a backup at GSFC. For GOES-R
West   (135º W (TBS)) the primary CDAS is located at Wallops Island, VA with
a   backup at Fairbanks AK. For GOES-R Central (P^3I) (105º W) the primary
and   backup CDAS are TBS.

ID:
6573

Downlink: Earth Coverage to 5º-elevation angle

ID:
6574

The spacecraft described in the Space and Launch Segment will support this capability.

ID:
4515

2.11 Satellite System

ID:
4516

2.11.1 Recovery after Spacecraft Maneuvers

ID:
4517
The spacecraft system shall be capable of performing any maneuvers, including yaw flip, in 1.5 (TBR) hours.

ID:
4518
Discussion: Routine operations should not be re-established too quickly to endanger the health or safety of the instrument.

ID:
4519
Benefits: Excessive delays in resuming routine sounding operations following mandatory outages associated with maneuvers can threaten continuity of weather surveillance and result in degradation of forecasts of severe weather.

ID:
4520

2.11.2 Removed

ID:
4521

2.11.3 Shortfalls in Meeting GEO observational needs

ID:
4522
Some of the GPRD-1 requirements will not be met by the current instrumentation planned for GOES-R due to finite resources, whether temporal or financial. The contents of this section may change over time with any changes in allocated resources.

ID:
5863
It is important to note that all TBS values listed as GOES-R product requirements are "To Be Supplied by the government". The GOES Program office will maintain control over the supplied values. Many of these values will require detailed study over the period of several years to assess the capability of the system, particularly when TBS was used for measurement accuracy values.

ID:
4523
2.11.3.1 Full shortfalls

ID:
4524
None.

ID:
4525
2.11.3.2 Partial shortfalls

ID:
4526
The items listed below represent cases where the letter of the description in the GPRD-1 requirements is not met by the GOES in every parameter but the spirit of the requirements is met. This section is intended to clarify how the spirit of the requirement is met by the planned capabilities of the instruments.

ID:
4527
As noted in section 1.4.6, both ABI and HES will contribute together to produce products. Typically the HES operated more slowly that the ABI and thus it will provide background information that will be updated whenever new HES data is available. The products will use the most recent ABI data as well. Thus, the joint product requirements typically carry the parameters of the ABI (spatial resolution, updates, etc.), considered HES data as the background field rather than imposing the product requirements on the HES as well as on the ABI.

ID:
4528
Cloud Base Height cannot be determined well from GOES. HES will provide feature altitude information the IR signal does not permit retrievals to be performed through clouds, only above clouds. ABI can provide information about cloud horizontal spatial coverage, but does not provide extensive information about vertical coverage. Thus the product will be measured to the extent possible with GOES and with the currently planned instrument parameters. Model outputs will also be employed to generate the product.

ID:
4529
Cloud Layers and Height is limited in the same way as the Cloud Base Height product described in the paragraph above. Thus the product will be measured to the extent possible with GOES and with the currently planned instrument parameters. Model outputs will also be employed to generate the product.

ID:
4532

Volcanic ash can be detected by ABI to meet the refresh rates, but the top height will be supplied by HES, not ABI, which is less frequently than specified.

ID:
4533
Flood Standing Water Detection can be provided by ABI but 5 cm vertical resolution measurements are not possible with ABI; HES data will not necessarily provide 5 cm vertical resolution in deeper standing water.

ID:
4535
ABI will contribute to determinations of the Currents---Offshore: Hemispheric but the measurement accuracy of 0.5 m/sec for some users will not be met.

ID:
4537
The capping inversion Information and the Moisture Flux accuracies are TBS since the government must validate them.

ID:
4538
The visibility: coastal measurement accuracy is TBS since the government must validate it.

ID:
4539
The ocean color measurement accuracy must be revalidated by the government.

ID:
4540
Currently Snow Depth can only be performed by ABI over the plains, where the detection of prairie grass in the snow can serve as an algorithm. Thus the product met by GOES-R is called snow depth over plains.

ID:
4541
The following radiation terms can be determined indirectly through limited spectral measurements from ABI and HES and can be determined to improved accuracy when combined with solar data from other instruments: Downward Solar Insolation: Surface/CONUS, Downward Solar Insolation: Surface/ Hemispheric, Downward Solar Insolation: Surface/ Mesoscale, Reflected Solar Insolation: TOA/ CONUS, Reflected Solar Insolation: TOA/ Hemispheric
The following radiation terms can be determined indirectly through limited spectral measurements from ABI and HES when combined with model outputs or with solar data from other instruments: Downward Longwave Radiation: Surface/ Hemispheric.

ID:
4542

2.11.4 Pre-planned Product Improvement (P^{3}I)

ID:
4543
The following description of P^{3}I has been quoted from the GPRD-1. "The purpose is to facilitate the early fielding of a GOES-R system, which can fulfill the vast majority of the designated mission requirements and includes a plan to incorporate improvements to the system after initial fielding. P^{3}I will allow the fielding of GOES-R by the IOC need date and, eventually, significantly more of the capability desired by GOES-R user community. It also reduces program risk and up-front program costs. P3I includes programming resources to accomplish an orderly and cost-effective evolution of a system's capability after fielding. The objectives of P3I are:

ID:
4544
Introduction of higher technological performance during system lifetime through more rapid fielding of technological advances

ID:
4545
Shortening of acquisition and deployment times

ID:
4546
Reduction in system technical, cost and schedule risk

ID:
4547
Extension of system useful life (preventing early obsolescence)

ID:
4548
Reduction of requirements for major system new starts

ID:
4549
Improvement of system operational readiness during the system's lifetime

ID:
4550
This approach will allow the GOES-R Program to develop and produce the basic system while pursuing the technologies required for improvements in parallel with the basic system. This means that funding for the development of the incremental upgrades are part of the original programs funding line and are not handled as a new start."

ID:
6328

Product requirements that have been recorded as P^{3}I for GOES-R over the global scale will not be met in the GOES-R series timeframe by additional satellites due to their location outside of the planned GOES-R coverage. However the data needs relevant to these requirements will be addressed by international partners as part of an international network of geostationary and other satellites covering these global geographic regions. In addition the GOES-R program will interface will these international partners (TBD). These global products are the nominally the equivalent of the ABI and HES products on the global scale, dominated by the weather products.

ID:
4551
In terms of the constellation, the P^{3}I improvements may be in terms on additional instrument deployed after the start of the GOES-R series. In terms of the individual instruments, the improvements may be in terms of modularity of the instrument elements that, upon installation to subsequent instrument in the series, would yield improved performance for product enhancement.

ID:
4552
Requirements that fall into this category are listed below, along with a brief reason for the P^{3}I classification.

ID:
4553

ID:
4554
True color imagery (Full Disk)   Primarily met by other ABI bands, but could be met by P^{3}I Hyperspectral Imager

ID:
4555
Hail detection: CONUS   Microwave

ID:
4556
Hail Detection: Hemispheric   Microwave

ID:
4557
Hail Detection: Mesoscale   Microwave

ID:
4558
Precipitation Type / Rate: CONUS   Microwave

ID:

4559
Precipitation Type /Rate: Hemispheric   Microwave

ID:
4560
Precipitation Type /Rate: Mesoscale   Microwave

ID:
4561
Atmospheric Vertical Moisture Profile: CONUS, All weather   Microwave

ID:
4562
Atmospheric Vertical Moisture Profile: Hemispheric, All weather   Microwave

ID:
4563
Atmospheric Vertical Moisture Profile: Mesoscale, All weather   Microwave

ID:
4564
Atmospheric Vertical Temperature Profile: CONUS, All weather   Microwave

ID:
4565
Atmospheric Vertical Temperature Profile: Hemispheric, All weather   Microwave

ID:
4566
Atmospheric Vertical Temperature Profile: Mesoscale, All weather   Microwave

ID:
4567
Capping Inversion: CONUS, All weather   Microwave

ID:
4568
Capping Inversion: Mesoscale, All weather   Microwave

ID:
4569
Moisture Flux: CONUS, All weather   Microwave

ID:
4570
Moisture Hemispheric: CONUS, All weather   Microwave

ID:
4571
Moisture Flux: Mesoscale, All weather   Microwave

ID:
4572
Total Water Content: CONUS, All weather   Microwave

ID:
4573
Total Water Content: Hemispheric, All weather   Microwave

ID:
4574
Total Water Content: Mesoscale, All weather   Microwave

ID:
4575
Tropical Cyclone Inner Core Temperature: Mesoscale   Microwave

ID:
5848
    Radiances: CONUS: Microwave (all weather)   Microwave

ID:
5849
    Radiances: Hemispheric: Microwave (all weather)   Microwave

ID:
5850
    Radiances: Mesoscale: Microwave (all weather)   Microwave

ID:
5852
    Snow Depth: CONUS   Microwave

ID:
4577
    Snow Depth: Hemispheric   Microwave

ID:

4578
Snow Depth: Mesoscale   Microwave

ID:
4579
Snow Water Equivalent: CONUS   Microwave

ID:
4580
Snow Water Equivalent: Hemispheric   Microwave

ID:
5853
Soil Moisture: CONUS   Microwave

ID:
4582
Soil Moisture: Hemispheric   Microwave

ID:
6349
Sea & Lake Ice/Surface Temp: CONUS P^3I Hyperspectral Imager due to spatial
resolution

ID:
5854
Surface Type: Hemispheric P^3I Hyperspectral Imager and another far
                                            IR instrument and Microwave

ID:
5855
Ice of Land Origin (Icebergs and Ice Shelves): Hemispheric P^3I Hyperspectral Imager

ID:
5856
Ocean Wave Characteristics: Significant Wave Height,   Microwave (low res)
    Direction, Period: CONUS

ID:
5857
Ocean Wave Characteristics: Significant Wave Height,   Microwave (low res)
    Direction, Period: Hemispheric

ID:

6357

Sea and Lake Ice: Edge

P3I Hyperspectral Imager

ID:
5858

Sea Surface Temperature: Coastal

Possibly P^{3}I Hyperspectral Imager

ID:
5859

Sea Surface Temperature: CONUS

Possibly P^{3}I Hyperspectral Imager

ID:
5860

Sea Surface Temperature: Hemispheric

Possibly P^{3}I Hyperspectral Imager

ID:
5861

Sea and Lake Surface Winds: CONUS

Microwave

ID:
5862

Sea and Lake Surface Winds: Hemispheric

Microwave

ID:
4583

Sea Surface Winds: Coastal

Microwave

ID:
4584

Sea Surface Winds: Coastal/Offshore

Microwave

ID:
4585

Sea Surface Winds: Hemispheric

Microwave

ID:
4586

Sea Surface Winds: Mesoscale

Microwave

ID:
4588

Total Electron Content (TEC)

Requires Incoherent Scatter active Radar
(interference problems) or in situ sensor

ID:
4589

Auroral Boundary	Separate UV sensor or part of Hyperspectral Imager

ID: 4590

Airglow Emissions and Airglow	P^3I Hyperspectral Instrument

ID: 4592

Auroral Energy Deposition	Separate UV sensor or part of Hyperspectral Imager

ID: 4593

Auroral Imagery	Separate UV sensor or part of P^3I Hyperspectral Imager

ID: 4594

Electron Density Profiles	Requires Active Radar (interference problems) or in situ sensor

ID: 4595

Ionospheric Scintillation	Requires Incoherent Scatter active Radar (interference problems) or in situ sensor

ID: 4596

Neutral Density Profile	Requires Incoherent Scatter active Radar (interference problems) or in situ sensor

ID: 4597

Optical Backgrounds	P^3I Hyperspectral Instrument

ID: 4600

Upper Atmospheric Neutral Winds	Low quality at best with P^3I Hyperspectral Imager; high quality winds requires separate complex instrument

ID: 5847

Downward Solar Insolation: TOA/CONUS	Solar Irradiance Monitor

ID:
4601
      Solar Flux: Spectral Irradiance   Solar Irradiance Instrument

ID:
4602
      Solar Flux: Total Irradiance   Solar Irradiance Instrument

ID:
4603
      Solar Radiation Imagery: Corona Images   Solar Coronagraph

ID:
4604
      Solar Radiation Imagery: EUV Images   Other new instrument, may be part of more complex Solar Coronagraph

ID:
4605
Solar Radiation Imagery: Far IR and Optical Images   Other new instrument; may be part of more complex Solar Coronagraph

ID:
4606
      Solar Radiation Imagery: Magnetoheliograph   Other new instrument or expanded magnetometer capabilities

ID:
4607
      Solar Radiation Imagery: Solar Radio   Other new instrument or part of very
            (Total Flux and Burst Location)   expanded Solar Irradiance Instrument

ID:
4608
Absorbed Shortwave Radiation: Surface/ Hemispheric   Proxy from ABI and Solar Irrad. Monitor

ID:
4609
Absorbed Shortwave Radiation: Surface/ Mesoscale   Proxy from ABI and Solar Irrad. Monitor

ID:
4612
      CH_4 Concentration   HES, but requires extensive integration time time and competes with other tasks

ID:
5851

CO$_2$ Concentration	Other new instrument or HES but requires extensive integration and competes with other tasks

ID:
4613

Ozone Layers	HES, but research applications for product require more than two large layers

ID:
4614

2.11.5 Interface to Other Segments

ID:
4615
Interface to Ground Segment

ID:
4616
Removed

ID: 4617

3 Ground Segment

ID: 4618
This segment is described in Section 3.3.

ID: 6406

Definitions

ID: 4619
The following definitions for this Segment are provided here to clarify requirements, in all the following Groupings, using the defined terms.

ID: 4620

An **anomaly** is a deviation or departure from the normal. It doesn't necessarily require an action, but it needs to be explained and or investigated.

ID: 4621

A **contingency** is either a description of an activity, or a type of procedure or other documentation written to correct, and/or prevent, and/or mitigate a potential problem or an anomaly.

ID: 6318

Raw Data: Data in their original packets, as received from a satellite.

ID: 6319

Level 0: Reconstructed unprocessed instrument data at full space-time resolution with all available supplemental information to be used in subsequent processing (e.g. ephemeris, health and safety) appended.

ID: 6320

Level 1a: Unpacked, reformatted and resampled level 0 data, with all supplemental information to be used in subsequent processing appended. Data generally presented as full space/time resolution. A wide variety of sub-level products are possible.

ID: 4622

Level 1b data: Unpacked, reformatted, and resampled level-0 data, with all supplemental information to be used in subsequent processing appended. Radiometric and geometric correction applied to produce parameters in physical units. Data generally presented as full space/time resolution. (This is identical to the earth-referenced instrument data with radiometric calibration applied and all calibration data appended).

ID: 6321

Level 2: Retrieved environmental variables (e.g. sea surface temperature) at the same resolution and location as the level 1 source.

ID: 6322

Level 3: Data or retrieved environmental variables that have been spatially and/or temporally resampled (i.e. derived from level 1 or 2). Such resampling may include and averaging and compositing.

ID: 6323

Level 4: Model output or results from analyses of lower level data (i.e. variable that is not directly measured by the instruments, but is derived from these measurements.

ID: 4623
Real time is the designation applied to the propagation of data through a system with minimum time delays. Examples of minimum time delays include any of the following: speed of light propagation; buffering due to compressing, packetizing, framing, and coding; and channel sharing such as required for the CCSDS CVCDU protocols.

ID: 6340
Mean Time to Failure is the expected time that a system/component will operate before the first failure will occur.

ID: 6407
Mean Time Between Failure is defined as the average time that a system/component works without failure.

ID: 6341
Mean Time to Repair is the average time required to repair a system/component

ID: 4624
Absolute Time Sequence is defined as a sequence of numbered commands programmed such that each command executes at a specific time.

ID: 4625
Relative Time Sequence is a sequence of numbered commands programmed such that each command executes at a time relative to the execution time of the previous command in the sequence.

ID: 4671
The Ground Segment (GS) for the GOES R series of satellites, as foreseen at this time, is described below. This scenario may change as the needs of the system are defined over time. If this is the case, subsequent versions of this document will reflect these changes. The Government Reference Architecture is described in detail in a separate document.

ID: 4672
Figure 5 'Ground Segment Functional Diagram' shows the high level functionality of the Segment. Note that this diagram is intended to be functional only, i.e., system architecture and specific data and operations flow paths are not indicated. Other parts of the NOAA infrastructure are shown in the shaded areas and the Ground Segment is shown as a rectangle. Note that the flow of data into the Ground Segment indicates that the data will be used by one or more functions within the Ground Segment. The

requirements associated with each function indicate the use of this data and the Government Reference Architecture document indicates the flow of the data. As indicated, the Ground Segment provides the Mission Management (encompassing Space/Ground Communications and Satellite Operations); processes Sensor Data (SD); encompasses Cross Cutting and Enterprise functions, archives and distributes data and products and interfaces with other Segments and organizations as required.

ID: 4673
The major **functions** are:

ID: 4674
Mission Management
  Space/Ground Communications

ID: 6408
      Preprocess downlink data.

ID: 6409
      Manage uplinks and downlinks

ID: 6410
      Provide Unique Payload Services uplink/downlink

ID: 6411
      Perform Health Assessment

ID: 4675
      Removed

ID: 4676
      Removed

ID: 4677
      Removed

ID: 4678
       Removed

ID: 4679
       remove

ID: 4680
  Satellite Operations

ID: 4681

Generate spacecraft commands and command sequences for uplink

ID: 4682

Determine spacecraft orbit and attitude using star look, range, and landmark data

ID: 4683

Monitor satellite SOH

ID: 4684

Mission planning

ID: 4685

Perform engineering analysis and trending

ID: 4686

Support alignment and instrument calibration of satellites in GOES-R series

ID: 4687
Product Generation

ID: 4688

Determine alignment and instrument calibration parameters

ID: 4689

Generate Raw and Sensor Data Records (Level 0 and Level 1b)

ID: 6412

Generate Level 2 and level 2+ products

ID: 4690

Perform Image Navigation and Registration (INR)

ID: 4691

Generate and monitor GRB and a complete set of Level 1b data (GFUL)

ID: 6413

30-day local storage of downlink data and selected Products

ID: 4692
Crosscutting and Enterprise Functions

ID: 4693
 Configuration Management

ID: 4694
 Ground Data Flow monitoring and reporting

ID: 4695
 Ground hardware and software element monitoring and reporting

ID: 4696
 Maintenance and Documentation

ID: 4697
Removed

ID: 6414
Product Distribution
 Delivery of Archival Products to NESDIS Enterprise Infrastructure Interface
 Delivery of products and Mission data to User portals

ID: 6415
NESDIS Enterprise Infrastructure Interface
 Long-term product archiving through CLASS

ID: 6416
User Interface and Assimilation
 Interfacing with the user in area of data assimilation
 Training for those who interact with the GOES-R system data and operation

ID: 4698

Figure 5. Ground Segment Functional Diagram

ID: 4699
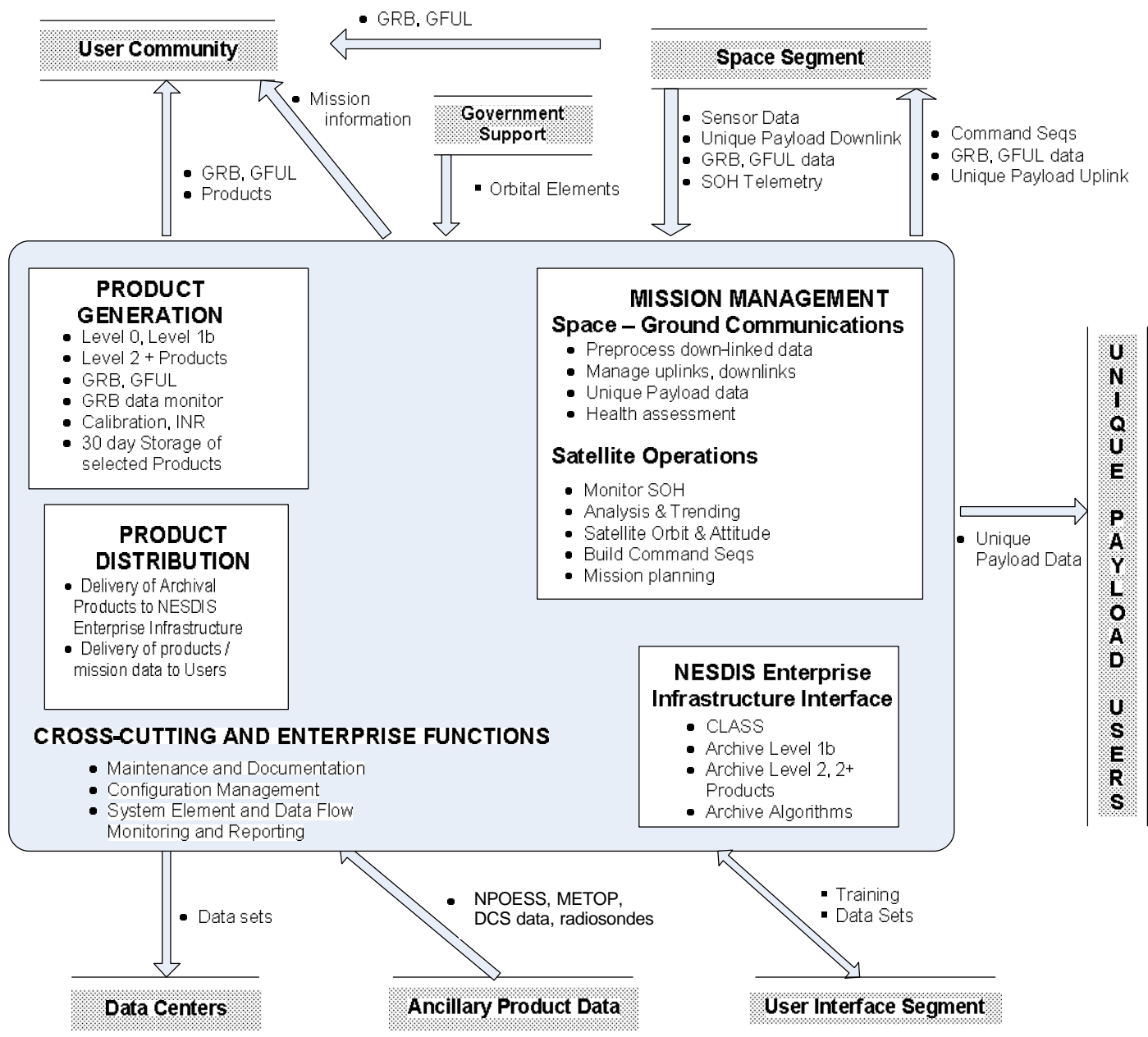
Note that the Unique Payload Services are the Low Rate Information Transmission (LRIT), Emergency Managers Weather Information Network (EMWIN), Data Collection Platform Interrogation (DCPI), Data Collection Platform Report (DCPR), Search and Rescue Satellite Aided Tracking (SARSAT), and NOAA Ships Ocean Data Support (Ships). At the time that the GOES R series becomes operational, it is expected the types of Unique Payload Services will be the same as provided by the current system (GOES-N) (indicated as 'continuing service' in this document), with the exception of the Ships, which will be investigated further. It should be noted that some Unique Payload Services may need to provide additional data or functionality, which would require increased transmission rates or added GL Segment operations for these services. Where necessary to be compatible with the primary services, frequency changes may be made for any or all of the Unique Payload Services.

ID: 4700
The GL **Segment** will accommodate the increased amount and accuracy of the sensor data associated with the GOES R series Imager and Sounder. Automatic or minimal manual operations are provided for routine daily operations such as schedule generation, scheduler processes, monitoring, and correction of spacecraft anomalies. The uplink rate supports large memory capacity instruments and spacecraft equipment. An integral part of the GOES R Ground Segment is a System Element and Data Flow functionality that includes monitoring of data flows (command/telemetry and all mission data) within the ground system and automatic correction of anomalous network/system hardware and software behavior. Security measures are incorporated in the Ground Segment that prevent unauthorized access to command streams and provide positive isolation of control functions to reduce risks associated with controlling multiple spacecraft and payloads. Further descriptions of the functional groupings are located under their relevant sections below.

ID: 4701
 Removed

ID: 4626

3.1 Implications of Mission Requirements Crossing All Segments

ID: 4627

3.1.1 Mission security in this segment

ID: 4628

Security shall be maintained in the GL Segment communications so that there is no unlawful interference or malicious introduction of agents or data in the required transmissions and receptions. Security measures shall be incorporated in the GL Segment to both prevent unauthorized access to command streams and provide positive isolation of control functions to reduce risks associated with controlling multiple spacecraft and payloads.

Discussion: Section 3.4.5.2 Command Encryption contains additional requirements that also pertain to mission security in the MM functional grouping of the GL Segment. Section 1.4.3.3 contains a web page reference to NOAA IT security standards.

ID: 4629

3.1.2 End to end validation in this segment

ID: 4630

The GL Segment shall provide end-to-end validation of data transfers between all GL Segment interfaces.

ID: 5241
The User Interface Grouping (UIS) will validate the operability of training tools.

ID: 5242
The UIS will revalidate the appropriateness of the training tools on every TBS years.

ID: 5243
The UIS will perform surveys to determine user satisfaction.

ID: 4631

3.1.3 Configuration Management and Documentation

ID: 4632

3.1.3.1 Configuration Management

ID: 4633
The GL Segment shall maintain configuration control of hardware, software, documentation, and databases.

ID: 4634
The GL Segment shall use a Configuration Management approach, subject to Government approval, tailored to the Life Cycle processes associated with the GL Segment.

ID: 4635

The GL Segment Configuration Management approach shall include, but not be limited to, the following activities: Configuration Identification, Configuration Control, Configuration Status Accounting, Configuration Evaluation, Release Management and Delivery, and other items that are TBD.

ID: 4636

3.1.3.2 Documentation

ID: 4637
All GL Segment hardware and software shall be described in appropriate engineering documentation.

ID: 4638
All GL Segment engineering documentation shall be delivered to configuration management controlled by CM and maintained.

ID: 4639
All documentation shall be prepared according to documentation standard subject to government approval.

ID: 4640
Discussion: The documentation will be developed to a level to support operations, sustainment, upgrade, modification, and re-procurement of all hardware and software. This documentation includes both COTS and custom software.

ID: 4641
Operations and Maintenance (O & M) manuals for all hardware and software provided with the GL Segment shall be provided in electronic form.

ID: 4642
At a minimum, this includes configuration, installation, and interconnect diagrams.

ID: 4643
O & M manuals for all operations within the GL Segment shall be provided in electronic form.

ID: 4644
This includes at a minimum functional operations description. The GL Segment should use vendor-supplied ICD for each electrical and data transfer media interface with the GL Segment, including links

to domestic, civilian, or military communications networks, and existing facilities at the SOCC, CDAs, processing centers and Direct Receive Sites.

ID: 4645

3.1.3.3. GL Segment Training

ID: 4646

Removed

ID: 5272

3.1.3.3.1 Training for satellite operators

ID: 5273
In light of the new systems and the new satellites, training shall be made available for all who interact with the new systems and the data from the new systems.

ID: 5274
Discussion: Either videoconference training or in person training will be necessary for current and future satellite operators.

ID: 6417
The training shall use an approach, subject to government approval that employs the following:
    Operator interfaces during training that emulate the actual system with high fidelity.
    Simulated system performance with high fidelity to the actual system
    Test data sets reflecting the characteristics of the operational satellite(s) with high fidelity.
    Operational scenarios reflecting the characteristics of the actual operation situations with high fidelity.

ID: 4647

3.1.4 System Availability

ID: 4648
The GL Segment shall have no single point failures.

ID: 4649

The Operational Availability for the GL Segment shall be at 98.9 (TBR), where the Operational Availability incorporates hardware elements, hardware functions, and software functions.

ID: 4650
Discussion: This includes downtime for maintenance.

ID: 4651
MM shall have an availability of 0.9999 for Satellite Operations on a monthly basis.

ID: 4652

Discussion: This includes downtime for planned maintenance and other functions.

ID: 5027
The Operational Availability for the PG Grouping shall be at least 99.7% (TBR), where the Operational Availability incorporates hardware elements, hardware functions, and software functions.

ID: 5028

Discussion: This includes downtime for maintenance. Note that 99.7 % is achieved currently and corresponds to outages totaling 4.32 minutes a day.

ID: 5029
The PG Grouping shall have an availability of 0.9999 (**TBR**), on a monthly basis, for components associated with the generation of Critical Life and Property products (**TBS**).
Discussion: This includes downtime for planned maintenance and other functions.

ID: 6418
The Operational Availability for the PD Grouping shall be at least 99.9 % (TBS), where the Operational Availability incorporates hardware elements, hardware functions, and software functions.

Discussion: This includes downtime for maintenance.

ID: 6419
The PD Grouping shall have an availability of 0.9999 (**TBR**), on a monthly basis, for components associated with the generation of Critical Life and Property products (**TBS**).

ID: 5148

The Operational Availability for the NESDIS Enterprise Infrastructure Interface shall incorporate hardware elements, hardware functions, and software functions.

ID: 6041

Discussion: This includes downtime for maintenance

ID: 5149

The NESDIS Enterprise Infrastructure Interface shall have an availability of 0.9999 (***TBR***)**,** on a monthly basis, for components associated with the generation of Critical Life and Property products (**TBS**).

ID: 5252

The UIS shall have an availability of 0.9999 (***TBR***)**,** on a monthly basis, for elements involving software training that are critical to life and property. (TBR)

ID: 4653

Availability should be substantiated with at least:
      1)   Measures of Mean Time Between Failure (MTBF) and Mean Time to Repair (MTTR) for all components
      2)   Reliability analyses addressing redundancies.

ID: 4656

3.2 Implications of Mission Requirements Crossing Multiple Segments

ID: 4657

3.2.1 Data latency in this segment

ID: 4658

Data latency between the measurement of the Sensor Data (SD) by the instrument and the collection of the SD data on the ground shall (TBD) for each instrument unless specified below.

ID: 4659

Data latency between the receipt of data at each GL Segment interface and the associated output of data to other GL Segment interfaces shall be (***TBD)***.

ID: 4660

For the Advanced Baseline Imager (ABI), calibrated, earth-located, co-registered (band-to-band) image data for CONUS frames shall be ready for dissemination at a NOAA ground station within 1 minute from the time the scanning of the CONUS area is complete. For the mesoscale frames, the latency is 30 second. Similar data from full disk frames must be received by the user portal in their entirety within 6 (TBS) minutes from the scanning end time (THRESHOLD) The GOAL is to improve the data timeliness for the full disk frames.

ID: 4661
For the Hyperspectral Environmental Suite (HES), calibrated, earth-located, co-registered (band-to-band) observed radiance data shall be ready for dissemination in their entirety at a NOAA Ground Station within five (TBS) minutes from the time the measurement of the location is complete (THRESHOLD). The GOAL is to improve the data timeliness to less than 30 (TBS) seconds. Making the radiance data (and derived products) available sooner will increase its value to both forecasters and numerical models.

ID: 5035
The latency between the receipt of the data by the PG grouping to the creation of the data products will be near real time (TBR). The latency between the creation of the data products and the distribution of the products to the user portals will be near real time (TBR).

ID: 5036
Discussion: Near real time means as close as possible to real time.

ID: 6420
The latency between the creation of the data products and the PD of the products to the user portals will be near real time (TBR).

Discussion: Near real time means as close as possible to real time.

ID: 5155

The latency between the requests for data to the initiation of the delivery of the data through the on-line system discussed below is TBD.

ID: 5156
The latency between the requests for data to the initiation of the delivery of the data through the bulk delivery discussed below is TBD.

ID: 6421

The GL Segment shall provide bandwidth to support the mission within latency requirements.
> *Discussion: This include the bandwidth required between functional groupings of the GL Segment*

ID: 4662

3.2.2 Communication Data Standards

ID: 4663

Communication Standards shall be Consultative Committee for Space Data Systems (CCSDS) Recommendations to the extent they can be applied without conflict with other requirements of this document.

ID: 4664

3.2.3 Maintainability

ID: 4665

The GL Segment shall perform maintenance on a non-interference basis with GL Segment operations.

ID: 4666

The GL Segment shall have an upgrade strategy that allows the insertion of the latest technology and operational capabilities to ensure the most cost effective technical and life cycle advantages during the life of the GOES R program.

ID: 4667

The GL Segment shall perform remedial and preventive maintenance for all elements during installation, system checkout and acceptance, Initial Operational Capability (IOC), FOC and extended maintenance periods as defined by NOAA.

ID: 5041

Discussion: FOC will be nominally at final acceptance.

ID: 4668

The GL Segment shall support facilities and functions implemented to respond to anomalies, faults, and failures.

ID: 4669
The GL Segment shall support maintenance of operational interfaces with other applicable GOES R Segments.

ID: 4670

3.3 General Ground System Requirements

3.3.1 System Capacity

ID: 4713
The GL Segment shall ingest, process, and store as a temporal archive, all raw data required to produce the full complement of GOES R series data and products as projected for Final Operational Capability (FOC).

ID: 4714
Discussion: Final Operational Capability for "day-one products" is defined in Section 3.5.

ID: 4715

The GL Segment shall satisfy all Segment functions, including those occurring simultaneously, with no interference or performance degradation of any other Segment functionality.

ID: 4716

3.3.2 Inter-segment/grouping Connectivity

ID: 4717
The GL Segment shall provide all inter-segment and inter-grouping communications between GL Segment and the Space and Launch Segment.

ID: 4718

3.3.3 Functional Grouping Connectivity

ID: 4719
The GL Segment shall provide all connectivity and necessary buffering between functional groupings within the GL Segment.

ID: 4720

3.3.4 Routing Performance

ID: 4721
The GL Segment shall provide sufficient bandwidth to support the mission.

ID 6422

3.3.5 Modularity

ID: 5070
GL Segment processes shall be modular and scalable to support changing requirements, reduce maintenance, and promote reusability.

ID: 6422
Information passed between modules shall be done by defined interfaces.
    Discussion: Formats and standard for these interfaces are TBD.

3.3.6 Ergonomic Requirements

ID: 5071
All GL Segment user-computer interfaces shall be in accordance with industry accepted ergonomic standards as approved by the Government.

ID 6022

3.3.7 System Element and Data Flow Monitoring and Reporting
ID 6423
Anomalies, servicing, faults, and failures reporting in the GL Segment shall be integrated.

ID: 5068
The GL Segment shall autonomously correct anomalies, faults, and failures wherever practicable.

ID: 5069
The GL Segment shall use operator-initiated scripted-correction of anomalies, faults, and failures wherever practicable.

ID: 6023

The GL Segment shall monitor the performance of hardware components, software components, and system functions to detect anomalies, faults, and failures and extract supporting information.

ID: 6024
The GL Segment shall monitor parameters characterizing data flow within the GS to detect anomalies, faults, and failures and extract supporting information.

ID: 6025
The GL Segment shall report, within an interval appropriate to the severity of the anomaly, fault, and/or failure, detected conditions and supporting information to appropriate personnel located throughout the GS whenever anomalies, faults, and failures occur or are resolved.

ID: 6026
The GL Segment shall generate, at a minimum, summary and statistical trend reports of anomalies, faults, and failures (***TBD***).

3.4 General Mission Management Functional Grouping

ID: 4671
The MM Segment for the GOES R series of satellites, as foreseen at this time, is described below. This scenario may change as the needs of the system are defined over time. If this is the case, subsequent versions of this document will reflect these changes.

ID 6424
The Mission Management Functional Grouping contains the same functionality of the former GL-C3 Segment.

ID: 4619
Removed

ID: 4702

3.4.1 Operational Lifetime

ID: 4703
The functions and capabilities specified for the MM functional grouping shall be provided for the life of the GOES R series mission(s).

ID: 4704

The MM functional grouping equipment shall be in place and meet all requirements at the primary and backup CDAs and SOCC prior to start of spacecraft Integration and Test (I & T).

Discussion: Spacecraft I&T is likely to be scheduled 2 years prior to launch readiness of GOES-R.

ID: 4705

3.4.2 Satellite Contact

ID: 4706

The MM functional grouping shall have continuous contact with the Satellite constellation.

ID: 4707

3.4.3 Operations Concurrency

ID: 4708

The MM functional grouping shall support configuration control, element and data flow monitoring and reporting, integration, test, and verification activities concurrent with MM functional grouping operation of primary satellites in the GOES-R series and data processing operations.

ID: 4709

3.4.3.1 Operations Legacy Interface

ID: 4710
The MM functional grouping shall transition, on a non-interference basis, from legacy to GOES R series operations. This transition shall apply to backup operations, continuity of data flow and processing, and ease of maintenance.

ID: 4711
The MM functional grouping shall overlap operations with GOES R series and legacy satellites as necessary and on a non-interference basis.

ID: 4712

ID: 4722

3.4.4 Mission Guidance

ID: 4723
The MM grouping shall provide mission operations guidance, including mission configuration, maneuver planning, satellite activity prioritization, and data handling.

ID: 4724

The MM Grouping shall make available mission operational information to the user community.

ID: 4725

3.4.1 Space/Ground Communications

ID: 4726

3.4.1.1 General

ID: 4727

3.4.1.1.1 Manage Space/Ground Communications

ID: 4728
The MM functional grouping shall manage and provide for space/ground communications during all appropriate test, ground and on-orbit storage, and operational phases for the life of the satellites in the GOES-R series.

ID: 4729
The MM functional grouping shall process data from communication links that are compatible with CCSDS Forward Error Correction (FEC) coding and framing processes to the extent they can be applied without conflict with other requirements of this document.

ID: 4730
MM functional grouping shall provide signal processing.
>   Discussion: Signal processing, as used here, is processing of the data stream associated
>   with moving the data from the antenna(s) to PG. This processing will include routing the

data according to instrument ID to the appropriate Product Generation port; data processing is processing of the data stream associated with the generation of Level 0, Level 1b, Level 2 and Level 2+ products from the data received from MM and other sources, as required.

3.4.1.1.2 Simultaneity of Command and Data Acquisitions (CDA) Communications Links

ID: 4731
The MM grouping shall concurrently schedule primary and backup ground stations, process telemetry, and monitor the following CDA communications links for the GOES R series:

ID: 4732
    a. Command, Command load, and DCPI uplinks

ID: 4733
    b. Uplink/downlink for GRB, LRIT, and EMWIN

ID: 4734
    c. Real-time telemetry downlinks

ID: 4735
    d. Sensor Data downlink

ID: 4736
    e. Downlink for DCPR

ID: 4737

3.4.1.1.3 Communications Status

ID: 4738

The MM grouping shall summarize and maintain space/ground communication status and report as necessary.

ID: 4739

Discussion: This pertains to reporting of any breaks in space to ground communication links.

ID: 4740

3.4.1.2. Assessment

ID: 4741
The MM grouping shall maintain an assessment of the space / ground communications functions.
Discussion: This pertains to real-time software and hardware.

ID: 4742

3.4.1.2.1 Antennas

ID: 4743
The MM grouping shall perform continuous antenna self checks.

ID: 4744
The MM grouping shall monitor and generate reports on antenna health status.

ID: 4745
The MM grouping antennas shall automatically track the GOES-R series

ID: 4746
The MM grouping antennas shall program track the GOES-R series

ID: 4747

3.4.1.2.2 Configuration Discrepancy Reporting

ID: 4748

The MM grouping shall generate and maintain summary reports of failures and discrepancies (including subsequent resolutions) in space / ground communication functions.

ID: 4749

34.1.2.3 Telemetry Downlink

ID: 4750

The MM grouping shall receive real-time telemetry from the satellites in the GOES-R series formatted according to the CCSDS Recommendation for Telemetry Channel Encoding.

ID: 4751
The MM grouping shall monitor and generate status on telemetry downlink functions.

ID: 4752

3.4.1.2.4 Sensor Data Downlink

ID: 4753
The MM grouping shall receive SD down-linked from the satellites in the GOES-R series according to the applicable CCSDS Recommendations to the extent they can be applied without conflict with other requirements of this document.

ID: 4754
The MM grouping shall monitor and generate status on SD downlink functions.

ID: 4756

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ID: 4759

3.4.1.2.5 Real-time Telemetry Preprocessing

ID: 4760
The MM grouping shall preprocess received telemetry in real-time according to the applicable CCSDS Recommendations.

ID: 4761

3.4.1.2.6 Sensor Data Downlink (SD) Preprocessing

ID: 4762

The MM grouping shall ingest and preprocess received SD in near real-time according to the applicable CCSDS Recommendations.

ID: 6027

Any delays shall not exceed latencies defined in under the products (first part) of each instrument/payload discussed in Section 2.10.

ID: 4763

3.4.1.2.7 Virtual Channel Prioritization

ID: 4764

The MM grouping shall forward data on the basis of assigned virtual channel identifiers.

ID: 4765

3.4.1.2.8 Preprocessing Status

ID: 4766

The MM grouping shall monitor and generate status on preprocessing functions.

ID: 4767

3.4.1.2.9 Data Quality Summary

ID: 4768

The MM grouping shall generate a real-time data quality summary.

ID: 4769

Discussion: This will include material such as counting the number of frames by source and accounting for the forward error correction process.

ID: 4770

3.4.2 Unique Payload Services

ID: 4771

The MM grouping shall provide functions as needed to support the Unique Payload Services described in Section 2.8.10.3.2. As described there, these include LRIT, EMWIN, DCPI, DCPR, Search and Rescue (SARSAT), and Ships.

ID: 4772

3.4.2.1 LRIT

ID: 4773
The MM grouping shall provide an RF interface with the LRIT Unique Payload Services defined in Section 2.10.8.3.2.3.

ID: 4774
The MM grouping shall provide LRIT functions as a continuing service.

ID: 4775
The MM grouping shall provide for LRIT increased data capacity as necessary.

ID: 4776

3.4.2.2 EMWIN

ID: 4777
The MM grouping shall provide an RF interface with the EMWIN Unique Payload Services defined in Section 2.10.8.3.2.4.

ID: 4778
The MM grouping shall provide EMWIN functions as a continuing service.

ID: 4779
The MM grouping shall provide for EMWIN increased data capacity as necessary.

ID: 4780

3.4.2.3 DCPI

ID: 4781

The MM grouping shall provide an RF interface with the DCPI Unique Payload Services defined in Section 2.10.8.3.2.2.

ID: 4782

The MM grouping shall provide DCPI functions as defined in Section 2.10.8.3.2.2.

ID: 4783

3.4.2.4 DCPR

ID: 4784

The MM grouping shall provide an RF interface with the DCPR Unique Payload Services defined in Section 2.10.8.3.2.2.1.

ID: 4785

The MM grouping shall provide DCPR functions as a continuing service.

ID: 4786

The MM grouping shall provide for DCPR increased data capacity as necessary.

ID: 4787

Discussion: As discussed in Section 0.2.2, DCS users project a large growth in usage, due to both more platforms and shorter report intervals. Additionally, the NWS estimates the value of DCS to be several billion dollars per year. These factors are likely to drive system loading near the capacity limits of the current DCPR system by the expected GOES R launch date. This will impact not only the Space and Launch Segment but also the Ground System Segment.

ID: 4788

3.4.2.5 Search and Rescue (SARSAT)

ID: 4789

The MM grouping shall provide, as necessary, an RF interface with the SARSAT Unique Payload Services Service defined in Section 2.10.8.3.2.1

ID: 4790

The MM grouping shall provide SARSAT functions defined in Section 2.10.8.3.2.1

ID: 4791

Removed

ID: 6575

3.4.2.6 **NOAA Ships Ocean Data Support (Ships)**

ID: 6576

The MM grouping shall provide, as necessary, an RF interface with the Ships Unique Payload Services Service defined in Section 2.10.8.3.2.5.

ID: 6577

The MM grouping shall provide Ships functions defined in Section 2.10.8.3.2.5.

ID: 4792

3.4.3 Data Flow

ID: 4793

3.4.3.1 Forward Real-time Telemetry

ID: 4794

The MM grouping shall forward SOH telemetry and raw sensor data in real-time.

ID: 4795

3.4.3.2 Capture Raw Sensor Data

ID: 4796

The MM grouping shall capture and retain raw SD for a minimum of 30 days.

ID: 4797

The MM grouping shall provide copies, on request, of the saved SD.

ID: 4798
3.4.3.3 Verify Received Versus Transferred

ID: 4799

The MM grouping shall verify data forwarded/transferred against the data received by Product Generation, and Product Distribution to resolve discrepancies.

ID: 6324
A test bed system for end-to-end testing of all components of the MM grouping shall be developed and maintained. This test-bed capability shall be maintained after launch to facilitate testing and implementation of new and improved products and services.

ID: 4800

3.4.4 Satellite Operations

ID: 4801

3.4.4.1 General

ID: 4802

The MM grouping shall provide all uplink(s) of Command and Control data to the GOES R Series including, as a minimum, commands, command loads, software, and spacecraft data.

ID: 4803

3.4.4.1.1 Calibrations and Alignments

ID: 4804

The MM grouping shall support satellite alignment and instrument calibration activities for the GOES-R series.

ID: 4805

3.4.5.1.2 Satellite Command and Control

ID: 4806

The MM grouping shall manage and provide command and control of the satellites in the GOES-R series during all appropriate test and operations phases for the life of the GOES-R series

ID: 4807

3.4.1.3 Removed

ID: 4808

3.4.1.4 Removed

ID: 4809

3.4.2 Mission Planning

ID: 4810

3.4.2.1 Mission Event Planning

ID: 4811
The MM grouping shall plan and schedule continuous satellite operations.

ID: 4812

3.4.2.2 Launch Planning

ID: 4813
The MM grouping shall plan and support launch and early orbit operations.

ID: 4814

3.4.2.3 Long Range Mission Planning

ID: 4815
The MM grouping shall plan and support long-range operations.

ID: 4816

3.4.2.4 Activity Schedule Development

ID: 4817
The MM grouping shall generate activity schedule of coordinated Satellite Operations, communications services, and supporting functions for each active satellite.

ID: 4818
The MM grouping shall generate activity schedules that span time durations to accommodate on-board capability.

ID: 4819

3.4.2.5 Satellite Maintenance Planning and Scheduling

ID: 4820
The MM grouping shall plan and schedule GOES-R series satellite maintenance service activities.

ID: 4821

3.4.2.6 Calibration Planning and Scheduling

ID: 4822
The MM grouping shall plan and schedule instrument calibration activities.

ID: 4823

3.4.2.7 Contingency Planning

ID: 4824
The MM grouping shall generate pre-planned responses to anomalous conditions for Satellite Operations.

ID: 4825

3.4.2.8 Anomaly Support

ID: 4826

The MM grouping shall plan and request support for anomalous operations on an emergency basis.

ID: 4827

3.4.3 Satellite Databases

ID: 4828

3.4.3.1 Satellite Command Database

ID: 4829
The MM grouping shall maintain a satellite command database for the life of each satellite.

ID: 4830

3.4.3.2 Satellite Telemetry Database

ID: 4831
The MM grouping shall maintain a telemetry database for the life of each satellite.

ID: 4832

3.4.4 Satellite Control and Monitoring

ID: 4833

3.4.4.1 Command Transmission Constraint

ID: 4834

The MM grouping shall necessitate operator interaction/confirmation for transmission of commands involving irreversible or degrading actions.

ID: 4858

The MM grouping shall maintain operations appropriate to the initiation, duration and cessation of transmission.

ID: 4835

3.4.4.2 Real-Time Telemetry Processing

ID: 4836

The MM grouping shall process telemetry from the GOES-R series in real-time.

ID: 4837

3.4.4.3 Telemetry Format Processing

ID: 4838

The MM grouping shall process all spacecraft telemetry formats.

ID: 4839

3.4.4.4 Health and Safety Analysis

ID: 4840
The MM grouping shall process and analyze the satellite state-of-health (SOH) telemetry.

ID: 4841
The MM grouping shall identify all out-of-limit conditions detected from the processing of all telemetry.

ID: 4842

The MM grouping shall configure limit conditions and functions.

ID: 4843

3.4.4.5 Verification of Load Receipt

ID: 4844

The MM grouping shall verify that all software, stored command and table loads transmitted to the GOES-R series have been received with no transmission errors.

ID: 4845

3.4.4.6 Verification of Command Execution

ID: 4846

The MM grouping shall verify that each command has been correctly executed based on telemetry.

ID: 4847

3.4.4.7 Verification of Load Storage

ID: 4848

The MM grouping shall verify that all software, stored command and table loads transmitted to the GOES-R series have been properly stored on board.

ID: 4849

3.4.4.8 Memory Verification

ID: 4850

The MM grouping shall command memory dumps from any or all satellite computers in the GOES-R series and perform memory verification.

ID: 4851

3.4.5 Command Preparation

ID: 4852

3.4.5.1 Authentication of and Validation of Commands

ID: 4853
The MM grouping shall authenticate all commands.

ID: 4854
The MM grouping shall validate all generated command loads.

ID: 4855

3.4.5.2 Command Encryption

ID: 4856

The MM grouping shall encrypt the command link using the method specified in TBS.

ID: 4857
Remove

ID: 4859

3.4.5.3 Command Stream Assembly

ID: 4860

The MM grouping shall assemble commands into a command stream according to the CCSDS Recommendation for Telecommand.

ID: 4861

3.4.6 Command Sequence Building

ID: 4862

3.4.6.1 Relative Time Sequence (RTS) Commands

ID: 4863
The MM grouping shall generate and use RTS commands in Satellite Operations.

ID: 4864

3.4.6.2 Real-time Commands

ID: 4865
The MM grouping shall generate real-time commands.

ID: 4866

3.4.6.3 Absolute Time Sequence (ATS) Commands

ID: 4867

The MM grouping shall generate and use ATS commands in Satellite Operations.

ID: 4868

3.4.6.4 Command Load

ID: 4869
The MM grouping shall schedule GOES-R series satellite resources.

ID: 4870

The MM grouping shall build satellite(s) command loads.

ID: 4871

3.4.6.5 Command Load Updates

ID: 4872

The MM grouping shall prepare stored command load updates.

ID: 4873
Discussion: The MM grouping needs to be able to build a load for part or all of any table on the spacecraft. This is especially important when working with absolute timed command loads, which may be very large. It is necessary to build replacement commands with associated time and command numbers that are constraint checked with the currently executing load (the copy of that load will be on the ground). The spacecraft will have a corresponding capability to accept and process the partial load.

ID: 4874

3.4.6.6 Command Load Sizing

ID: 4875
The MM grouping shall generate stored command loads that span time durations that accommodate on-board capability.

ID: 4876

3.4.6.7 Command Load Processing

ID: 4877

The MM grouping shall generate, constraint check, and up-link stored command loads.

ID: 4878

 3.4.6.8 Contingency Procedures

ID: 4879
The MM grouping shall have predefined contingency procedures for non-nominal mission operations.

ID: 4880

3.4.7 Engineering and Analysis of Satellite Telemetry and Command Data

ID: 4881

3.4.7.1 Trend Analysis

ID: 4882

The MM grouping shall generate performance trend analyses using real-time and archived telemetry.

ID: 6028
Discussion: The analyses shall include (but not be limited to) standard statistical tests to determine statistically anomalous events. An example of a statistically anomalous event for a Gaussian distributed telemetry element would be the occurrence of seven increasing or decreasing values in a row. This rule is one of a set of rules known as the Western Electric rules.

ID: 4883

3.4.7.2 Satellite Performance Reports

ID: 4884
The MM grouping shall report GOES-R series satellite performance data.

ID: 4885

3.4.7.3 Command and Telemetry Archive

ID: 4886
The MM grouping shall archive all telemetry received from, and all commands and loads transmitted to, each satellite for the life of the satellite.

ID: 4887

The MM grouping shall archive all logs generated during the processing of telemetry data for the life of the GOES-R series.

ID: 4888

3.4.7.4 Operator Actions and Alarms

ID: 4889

The MM grouping shall log all out-of-limit conditions and operator actions.

ID: 4890

3.4.7.5 Archived Data Retrieval and Processing

ID: 4891

The MM grouping shall retrieve, process, and trend data archived within the MM grouping.

ID: 4892

3.4.7.6 Engineering and Analysis Archive Integrity

ID: 4893

The MM grouping shall ensure the engineering and analysis archive shall induce less than 1 bit error in 10^9 bits (**TBR**).

ID: 4894

3.4.7.7 Anomaly Resolution

ID: 4895
The MM grouping shall support anomaly investigation and resolution analyses.

ID: 4896

3.4.7.8 Conversion of SOH data to Engineering Units

ID: 4897
The MM grouping shall convert all SOH data to engineering units.
Discussion: This conversion is from digital counts to the relevant units, typically SI.

ID: 4898

3.4.8 Orbit and Attitude Tracking

ID: 4899
The MM grouping shall perform orbit maintenance activities to maintain the orbit for the life of the GOES-R series.

ID: 4900

3.4.8.1 Orbit/Attitude Correction Determination

ID: 4901
The MM grouping shall indicate if a correction to the GOES-R series satellite orbit or attitude is required.

ID: 4902

3.4.8.2 Orbit/Attitude Correction Planning

ID: 4903
The MM grouping shall plan attitude/orbit correction activities.

ID: 4904

3.4.9 Satellite Simulation

ID: 4905
The MM grouping shall provide satellite simulators that generate mode-dependent satellite telemetry in response to command sequences.

ID: 4906

3.4.10 Flight Software Maintenance

ID: 4907
The MM grouping shall maintain a current copy of the GOES-R Series satellite onboard software.

ID: 4908
The MM grouping shall archive each copy of the GOES-R series satellite on-board software for the life of the GOES-R series.

ID: 4909

3.4.10.1 Spacecraft Flight Software Maintenance

ID: 4910
The MM grouping shall maintain the spacecraft flight software.

ID: 4911

3.4.10.2 Spacecraft and Instrument Operations Table Maintenance

ID: 4912
The MM grouping shall maintain spacecraft tables.

ID: 4913
The MM grouping shall maintain general instrument operations tables.

ID: 4914

3.4.10.3 Instrument Flight Software Maintenance

ID: 4915
The MM grouping shall be capable of maintaining the instrument flight software.

ID: 4916

3.4.10.4 Instrument Calibration Table Handling

ID: 4917
The MM grouping shall receive and retain a copy of the instrument calibration tables from the associated instrument manufacturers and the PG grouping.

ID: 4918

3.4.10.5 Flight Software Verification and Validation

ID: 4919
The MM grouping shall validate and verify flight software and tables.

ID: 4920

ID: 4925

ID: 4921
The MM grouping shall provide all uplink(s) of operational data to the GOES R Series including, as a minimum, calibration data and instrument parameters.

ID: 4922
Discussion: Data distribution can be accomplished using a different component if it determined through concept studies and technology and risk trade analyses that this is more efficient.

3.4.11.1 Assemble as Instrument Source Packets to form RDRs

ID: 4926

The MM grouping shall de-multiplex Coded Virtual Channel Data Unit (CVCDU) data zones to reconstruct RDRs as generated by instruments prior to on-board packetization as described in the Interface Control Document ICD (***TBS***)

ID: 4927

3.4.11.2 Decompress RDRs

ID: 4928
The MM grouping shall decompress the RDRs utilizing algorithms appropriate for each instrument.

ID: 4929
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ID: 4930
Removed

ID: 4931

3.4.11.3 Assembly of Level-0 RDR Metadata

ID: 4932
The MM grouping shall assemble metadata in real-time for RDRs to include at a minimum (***TBD***):

ID: 4933
      a.   CCSDS header information

ID: 4934
      b.   Space - Ground ICD information

ID: 4935
      c.   Received-data quality indicators

ID: 4936

3.4.11.4 RDR Forwarding

ID: 4937
The MM grouping shall forward RDRs to the appropriate processing stream to interface with the PG functional grouping (TBR).

ID: 4938

Remove

ID: 4939
Remove

ID: 4940

3.4.12.1 GOES R Series Rebroadcast Data (GRB)

ID: 4972
The MM grouping shall have an RF interface for GRB as defined in Section 2.10.8.3.1.

ID: 4973
GRB shall be broadcast to users, in (TBS) format.

ID: 4974
GRB shall occur simultaneously with ingest of data streams from the Space segment.

ID: 4975
GRB shall occur on a continuous basis.

ID: 6029
Discussion: The two types of data that are currently being considered for GOES R are the availability of a full set of this data (GFUL) and a rebroadcast of a subset of this data (GRB). GFUL contains the full ABI, HES, and other instruments Level 1b data sets, providing a data rate of more than 100 Mbps. This data could be sent via ground network or satellite rebroadcast.
Discussion: GRB provides a replacement for the current Goes Variable Format Data (GVAR), as described in section 2.10.8.3.1.

ID: 4976

3.4.13 Product Monitoring

ID: 4977
The MM grouping shall provide the capability to display data and images from the GFUL/GRB data.

ID: 4978

The MM grouping shall perform radiometric data quality monitoring.

ID: 4979
The MM grouping shall perform INR data quality monitoring to include landmark verification.

ID: 4980
The MM grouping shall provide predictive orbit and attitude data to the INR function.

ID: 6030
Discussion: The Product Monitoring function(s) are intended to support not only product QA activities but also support troubleshooting of product anomalies occurring in other Ground System groupings. Toward this end, it is expected that the PM function will be replicated in all the Ground System groupings.

ID: 4981

3.4.15 Geo-location Accuracy

ID: 4982
The MM grouping shall geo-locate all instrument data in geodetic latitude and longitude. The data shall be corrected for attitude within the accuracy specified for each instrument in this MRD.

ID: 4983
3.4.15.1 Landmark Fit using RDR data

ID: 4984
The MM grouping shall use landmark target locations from the earth pointing knowledge database to apply to RDR data to determine actual versus predicted offsets.

ID: 4985
3.4.15.2 Orbit and Attitude Knowledge Data Base

ID: 4986
The MM grouping shall update the earth pointing knowledge database in real-time.

ID 6425
The MM grouping shall acquire orbital element sets.

ID: 4987

3.4.16 Component System Architecture

ID: 4988
The MM grouping shall autonomously correct anomalies, faults, and failures wherever practicable.

ID: 4989
The MM grouping shall use operator-initiated correction of anomalies, faults, and failures wherever practicable.

ID: 4990
The MM grouping primary and backup CDA shall have functionally identical RF and computer system architectures and specific programs that are operated and maintained using the same commands and procedures.

ID: 4991
The MM grouping SOCC functionality located at primary and backup CDAs shall have functionally identical computer system architectures and specific programs that are operated and maintained using the same commands and procedures.

ID: 4992
MM grouping processes shall be modular and scalable to support changing requirements, reduce maintenance, and promote reusability.

ID: 4993
All MM grouping user-computer interfaces shall comply with industry accepted ergonomic standards as approved by the Government.

ID: 4994
(blank)

ID: 4995

3.4.17 Segment/GROUPING Interfaces

ID: 4996

3.4.17.1 Space Segment

ID: 4997

The MM grouping shall interface with the Space Segment through the MM grouping communications capability and associated antennas.

ID: 5010

3.4.17.2 Launch and Contingency Support

ID: 5011
The MM grouping shall acquire orbital element sets for Launch and Contingency support.

ID: 5012

3.5 Product generation Functional Grouping

ID: 5013

3.5.1 Implications of Mission Requirements Crossing All Segments and Groupings

ID: 5014
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ID: 5044

3.5.2 General Information on NOAA data processing
ID 6426
PG shall provide data processing.
Discussion: Signal processing, as used here, is processing of the data stream associated with moving the data from the antenna(s) to PG. This processing will include routing the data according to instrument ID to the appropriate Product Generation port; data processing is processing of the data stream associated with the generation of Level 0, Level 1b, Level 2 and Level 2+ products based on the data received from MM.

ID: 5045

3.5.2.1 Science Algorithms

ID: 5046

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ID: 5047

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ID: 5048

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ID: 5049

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ID: 5050

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ID: 5051

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ID: 6427

Operational-certified production generation software systems shall be provided, where the term "operational-certified" denotes that the software has been demonstrated to meet all operational timeliness and product performance requirements.

ID: 6428
Operational-certified observing system performance monitoring and validations systems shall be provided, where the term "operational-certified" denotes that the algorithms have been demonstrated to meet all operational timeliness and product performance requirements.

ID: 6429
Removed

ID: 6430
All supporting algorithm theoretical basis documents and algorithm implementation documentation shall be provided.

ID: 6431
Training shall be provided.

ID: 6432

Software systems consisting of science and quality assurance algorithms shall be validated with pre-launch simulated test datasets and post-launch real observations to demonstrate that GOES-R product threshold requirements, specified in the GOES-R MRD are met.

ID: 6433

Discussion: The NESDIS Office of Research and Applications (ORA) will participate on the algorithm development integrated product team as the lead government participant for the NOAA portion of the development of operational-certified GOES-R product algorithms. With team coordination, ORA will establish partnerships, via announcement of opportunities, grants, contracts, and/or memorandum of understanding, with NOAA cooperative institutes, industry, other NESDIS offices, NOAA Line Offices and Programs, and other Government agencies.

ID: 6434
Discussion: The GOES-R product algorithm and processing system development cycle is envisioned to consists of five phases:

1) Exploratory (as part of Program Definition and Risk Reduction)
2) Operational product development (as part of Acquisitions and Operations)
3) Operational demonstration (as part of Acquisitions and Operations)
4) Operational transition (as part of Acquisitions and Operations)
5) Operational production (as part of Acquisitions and Operations)

The *exploratory* phase consists of developing processing, validation and archiving concepts, testing different algorithms, and exploring different processing scenarios with precursory prototype systems.

The *operational product development* stage consists of developing operational-certified product generation software systems for the scientific and validation algorithms and processing scenarios selected during the exploratory phase. This phase also includes the development of algorithms to generate the simulated datasets needed for the next phase.

The *operational demonstration* phase tests the operational-certified product generation software systems with simulated datasets. All product output files are validated for accuracy and compliance with specified requirements. Output files are also provided to allow users such as NCEP to develop and test the necessary infrastructure needed to use GOES-R products. The operational demonstration phase includes 24 hours a day and 7 days a week continuous simulated processing, which is needed for thorough testing of all software components to ensure that product-generation algorithms meet specified

requirements for a large variety of atmospheric and surface conditions, and to ensure that validation/long-term monitoring software systems, which will be used for post-launch sustained calibration/validation, work properly.

The operational demonstration software systems will also be used to process real post-launch GOES-R data as a final validation of the algorithm/processing systems, which were transitioned to operations. The software system will also be used to demonstrate algorithm improvements.

The fourth phase, *operational transition*, begins with providing to the operational system implementers the operational-certified product generation processing software systems, all algorithm implementation documentation, and testing datasets, including input and output data and all ancillary data. Transition teams will be formed. The government will provide continuing scientific and technical insight for implementation the operational software system for product generation and validation.

In the fifth phase, operational production, provide sustained validation of the radiances and derived products are needed. Troubleshooting and reactive maintenance will be performed operational production.

Incremental spiral development concepts ("build a little, test a little") will be employed during all phases, which means that Phase 2 does not mean the completion of Phase 1, Phase 3 the completion of Phase 2, and so on. Spiral development allows the continuous exploratory development of improved algorithms, supported by periodic operational demonstrations and implementations. As GOES-R science and algorithms mature, more activities will be directed towards the development of user-driven applications.

Phase 1 activities are included GOES-R Risk Reduction (GOES-R3) studies. GOES-R3 does not provide algorithm deliverables. Instead GOES-R3 provides exploratory concepts/algorithms and associated algorithm theoretical basis documents, in collaboration will the other key Algorithm Development Team members, which are then developed further into the Phase 2 operational-certified product processing systems. Phase 3 will provide demonstration of the capabilities developed in Phase 2, and a testbed for product enhancements and problem resolutions. All phases, particularly Phases 4 and 5 are collaborative efforts between the system implementers and the government including OSD, ORA, OSDPD and government centers. The government will provide insight to industry in the development, transition and validation of the GOES-R algorithms and processing systems; the government team will also include academia and commercial partners in the task of the appropriate algorithm assessment.

ID: 6435
3.5.2.1.1 Algorithm Product Development Program (PDP) Requirements

ID: 6436
Operational-certified software modules shall be developed using Algorithm Technical Basis Document (ATBD) algorithms, definitions, and any available basic research software.

ID: 6437

Operational-certified observing system performance monitoring and validation systems shall be developed.

Discussion: These systems will support sustained operational monitoring and validation functions.

ID: 6438
The calibration/validation plans for GOES-R shall be developed with government oversight and approval to facilitate guidance/oversight for its implementation.

Discussion:
The GOES-R Calibration Scientist will be supplied by the government. This scientist will provide insight for all GOES-R calibration and validation activities, will chair the GOES-R Calibration/Validation Steering Committee and serve as the NOAA co-chair of the NOAA/NASA Calibration Working Group, and will act as the NOAA point of contact for calibration and validation issues

ID: 6439
The capability to provide 24 hour a day and 7 days a week operational demonstrations system shall be provided.

ID: 6440
Testbed and operational systems shall have the same hardware configuration to ensure smooth transitions of algorithms.

ID: 6441
Full spatial and temporal resolution GOES-R instrument level 1b radiance datasets shall be simulated.
Discussion:
These datasets will be used to fully test all algorithms.

ID: 6442
The algorithms for producing GOES-R calibrated radiances shall be developed with government oversight and approval.

ID: 6443
The algorithms for deriving all geophysical parameters from all GOES-R sensor calibrated radiances shall be developed with government oversight and approval.

ID: 6444
Algorithms to generate and store metadata during real-time product processing shall be developed.

ID: 6445
The ongoing scientific validation of the products shall be performed by the government.

ID: 6446
 (**TBS**) Field campaign data and sustained independent validation observations (e.g. Marine Optical Buoy (MOBY)) shall be conducted with government oversight and to properly characterize the error characteristics of GOES-R observations and derived products.

3.5.2.1.3 Algorithm Development Documentation

ID: 6447
 Functional requirement documents for each product suite with associated dependencies shall be produced.

ID: 6448
Software design documents for each product suite shall be produced.

ID: 6449
An algorithm development procedural document, which includes specifications for software configuration management, shall be produced.

ID: 6450
Validation and test plans for each product suite shall be produced.

ID: 6451
Full documentation and software of all algorithms and operational-certified product generations systems shall be produced.

Discussion: The documentation will include algorithm theoretical basis document, the algorithm implementation document, test datasets, source code and executable code.

3.5.2.1.4 Algorithm Development Interfaces

3.5.2.2 OSDPD

ID: 6452

Algorithm/processing systems transition teams including government representation and oversight shall be formed and shall meet to ensure the smooth transition to operations.
Discussion: It is envisioned that this would specifically involve OSDPD as well as ORA.

ID: 6453
Continued scientific support, including the development of new algorithms as necessary, of the GOES-R operational product production for the life of the system shall be provided with government oversight and involvement.

3.5.3.21 Archive Functionality

ID: 6454
The prototype product formats needed for archive shall be developed.

ID: 6455
To ensure that requirements for archiving/metadata are fulfilled, the government shall be involved in the teaming and the oversight.
Discussion: This teaming with the government is expected to involve at least the ORA and the NOAA Archive Working Group.

Operational-certified algorithm source code and documentation for archiving shall be provided.

ID: 5052
Removed

ID: 5053

3.5.4 Operational Product Processing

ID: 5054

Major components shall include communication systems, ground computers, and documentation.
The operational PG Grouping shall meet all GOES-R product specifications from the GPRD-1fd as detailed in the MRD, including but not limited to product accuracy and coverage.

ID: 5055
A test bed system for end-to-end testing of all components of the PG Grouping shall be developed and maintained. This test-bed capability shall be maintained after launch to facilitate testing and implementation of new and improved products and services.

ID: 5057

3.5.5 Operational Processing

ID: 5058

The data rates of the GOES-R instruments to the ground are estimated in section 2.10.8.1.2. The decoded and uncompressed data volume is TBS. The PGDS systems shall be sized to produce products from all SD input at two times (TBS) (THRESHOLD) and 10 times (TBS) (GOAL) the data rate received from the MM Grouping.

Discussion: The minimum estimated uncompressed data rate is estimated to be ~50 Mbps for ABI, ~15 - 60 Mbps for HES, and total ~ 120 Mbps for all instruments. The minimum level 2 products estimate is ~150 Mbps. The maximum product data estimate is 1.5 Gbps.

ID: 5059
Discussion: Currently the plan is to send the SIS and SEISS level 0 data to SEC, while meeting the 3-second latency requirement.

ID: 5060

ID: 5065

3.5.6 System Component Architecture

ID: 5066
Removed

ID: 5067
The PG Grouping shall manage, develop, test, integrate, and place into operation the hardware and software system components for the maintenance of existing products and the development of new products.

ID: 6035
Discussion: Multiple processing strings operating concurrently may require concurrent ingest of data received from the MM Grouping or as time-delayed blocks. Some processing strings may require both entire sets of data and data extracted from single or multiple data sets. This could require file management services and buffering internal to the PG Grouping sized to meet both near-real-time and delayed transport of data.

ID: 5072

3.5.7.3 Product Generation System Elements

ID: 5073

3.5.7.3.1 General

ID: 5074
The PG grouping shall manage, schedule, and control data processing and resources within the PG Grouping.

3.5.7.4 Sensor Data Processing

ID: 6346
Cloud mask data shall be used to produce pointing information for the other instruments, primarily the slower HES.

ID: 6347
     Discussion: This may be performed in the PG, the MM, or in the spacecraft.

ID: 6348
Discussion: It should also address SDRs used in taking advantage of synergistic relations between different instruments. In a proof-of-concept test for synergistically using information from one instrument to acquire data for another or in this case one satellite platform to better acquire data from another, on February 5, 2004, the Geostationary Operational Environmental Satellite (GOES) Sounder Cloud Top Pressure (CTP) product and National Aeronautics and Space Administration (NASA)'s Science Goal Monitor (SGM) were used to perform a sensor web experiment. Two competing alternate scenes were loaded onboard Earth Observing (EO)-1 (initiated via SGM) and then 4 hours before overflight of the first potential scene, Rapid City, SD, SGM automatically queried the real-time hourly GOES Sounder cloud product to decide whether to proceed with the plan of taking Rapid City, SD or to switch the plan to taking Jornada, NM. As it turns out, Rapid City was very cloudy and Jornada was clear as can be seen from the map generated by GOES and therefore, EO-1 was autonomously commanded to switch targets. There was no manual intervention for this process.

ID: 4923
Remove

ID: 4924
The PG grouping shall generate time-referenced, time-ordered, instrument-specific Raw Data Records (RDRs) for each instrument.

ID: 5075
The PG Grouping shall ingest and preprocess received data in accordance with each data format.

ID: 5076

PG Grouping ingest and preprocessing shall include signal processing, decompression and decryption as required, and data routing.

ID: 5077

The PG Grouping shall ingest, process, and store all data required to produce the full complement of GOES R products as projected for FOC.

ID: 5078

The PG Grouping shall generate the full complement of GOES R products as projected for FOC.

ID: 4757

The PG grouping shall ingest and preprocess received SD to generate level 0 data.

ID: 4758

Discussion: The preprocessing regenerates the level 0 data after the stripping of the CCSDS information

ID: 5079

The PG Grouping System Elements shall be expandable to (TBS) growth in storage and processing capacity over the life of the GOES R Series.

ID: 6036

Discussion: The PG grouping may experience at least a doubling of products and services during its lifetime. Additionally, processing growth is expected as more sophisticated models and algorithms are developed to leverage the extensive bandwidth and coverage of the GOES R sensors.

ID: 6456

3.5.7.4.1 Satellite Performance Evaluation

ID: 4941

The PG Grouping shall evaluate the performance of the GOES-R series with respect to the image radiometry, geometry and temporal registration.

ID: 4942

3.5.7.4.2 Radiometric Calibration

ID: 4943
The PG grouping shall perform radiometric correction of science data using:

ID: 4944
Calibration sources, and

ID: 4945
Calibration parameters generated by the calibration processing provided by the instrument manufacturer.

ID: 4946
The PG grouping shall generate calibration parameters.

ID: 4947
The PG grouping shall perform radiometric correction of instrument data using algorithms supplied by the instrument manufacturer.

ID: 4948
Discussion: The instruments will measure any calibration sources such as the blackbody, the visible calibrator if present, and space look responses to be used in determining corrective calibration coefficients to apply to the data. Algorithms will be supplied by the instrument vendors to meet specific detector response curves. The calibration coefficients are applied to the instrument data to support image navigation processing.

ID: 4949
3.5.7.4.3 Geometric Calibration

ID: 4950
The PG grouping shall generate state-variables to include, at a minimum, orbit, attitude, gyro bias, and co-registration as used for determining geo-location of instrument samples (TBD).
Discussion: The ground processing determines the anticipated pointing against actual star and landmark measurements. Offsets are determined to support the proper selection and fixation of instrument sample pixels to a threshold ground sample distance. Any oversampling is removed in this process. From this process, the orbit and attitude knowledge based database is constantly updated. The performance of the spacecraft gyro system can be measured from this as well.

ID: 4951

3.5.7.4.3.1 Generate/Update Application Processing Coefficients

ID: 4952
The PG grouping shall generate and/or update application processing parameters based on radiometric and geometric characterization results.

ID: 4953

3.5.7.4.3.2 Determine need for Instrument Calibration Table updates

ID: 4954
The PG Grouping shall determine the need for updates to the instrument calibration tables on board the satellite.

ID: 4955

3.5.7.3.3 Record Instrument Updates

ID: 4956
The PG Grouping shall provide updated instrument calibration tables for subsequent uplink by MM grouping to the GOES-R satellite.

ID: 4957

3.5.7.3.4 Band-to-Band Registration

ID: 4958
The PG Grouping shall measure and assess band-to-band registration of the imaging and sounding instruments using instrument vendor supplied algorithms.

ID: 4959
Discussion: This is included in the processes that determine the geometric calibration parameter.

ID: 4960

3.5.7.3.5 Radiometric and Geometric Calibration Summaries

ID: 4961
The PG Grouping shall archive radiometric and geometric calibration data summarized for each calibration period.

ID: 4962

Discussion: The knowledge data base of radiometric and geometric calibration can be created by sampling the data extractions used in the sample by sample process over some sampling period to build a data base that will be used to measure trends in the performance of the detectors and spacecraft orbit and attitude maintenance.

ID: 4963
The PG Grouping shall append (TBD) metadata to each sensor data record.

ID: 4964

Discussion: These are appended to each level-1b record to enable users to process the level-1b data independent of other spacecraft data.   Typically, these variables include sampling mode, source, temporal, and spectral identifications, relation to sun and moon position, and instrument viewing angle from nadir. The variables also reference external instrument supplied algorithm documentation.

ID: 4965

3.5.7.4 GOES R Series Level 1b Data

ID: 4966
The PG Grouping shall make data available (method is TBD) for GFUL.

ID: 4967
GFUL shall consist of ABI, HES, and other instruments Level 1b data. GFUL shall be made available on a continuous basis.

ID: 4968
Discussion: The GOES Level 1b data consists of a set of processed, calibrated and earth-referenced instrument data that is made available to users after processing. GFUL contains the full ABI, HES, and other instruments Level 1b data sets, providing a data rate of more than 100 Mbps.

ID: 4969

ID: 4970

ID: 4971

ID: 6037
The PG Grouping shall provide the following monitoring and data quality functions:
- display data and images from the GRB data.
- perform radiometric data quality monitoring.
- perform INR data quality monitoring to include landmark verification.
- derive predictive orbit and attitude data.

ID: 6038
Discussion: The monitoring and data quality function(s) are intended to support not only product QA activities but also support troubleshooting of product anomalies occurring in other Ground System Groupings. Toward this end, it is expected that these functions will be replicated in all the Ground System Groupings.

ID: 5080

3.5.7.54 Legacy and Concurrent Operations

ID: 5081
The PG Grouping shall support configuration control, element and data flow monitoring and reporting, integration, test, and verification activities concurrent with PG Grouping primary data processing operations.

ID: 5082
The PG Grouping shall operate concurrently with legacy operations with no operational disruption on fulfillment of any requirement.

ID: 5083
Discussion: This transition legacy and concurrent operations will apply to backup operations, continuity of data flow and processing, product distribution, and ease of maintenance. The GOES R Series PG Grouping may be either separate from other NOAA operations supporting POES data processing as it currently does or may be combined with the NPOESS product generation systems to be delivered with the next generation polar satellite programs.

ID: 5084

3.5.7.65 System Capability

ID: 5085
The PG Grouping shall perform all Grouping functions, including those occurring simultaneously, with no interference or performance degradation of any Grouping functionality.

ID: 5086
Discussion: The PG Grouping should provide system throughput capacity to support product generation and product distribution functions within data latency requirements. At a minimum, the system should be capable of concurrently supporting two operational satellite configurations with the GOES R sensor payload and projected P^3I suite(s) as well as one additional satellite configuration in test mode. Note that data distribution can be accomplished using a different grouping if it is determined through concept studies and technology and risk trade analyses that this is more efficient.

ID: 5087

ID: 5088
The PG Grouping shall provide at least thirty days (TBR) of untended storage for, at a minimum, the following data:

ID: 5089
  a. All received data records

ID: 5090
  b. Level 0 and any derived (e.g. level2, 3) Products

ID: 5091
  c. Metadata

ID: 5092

d. Other science data being used in PG Processing

ID: 5093
The PG Grouping shall provide bandwidth for all System networks to support the mission within latency requirements.

ID: 5094
The PG Grouping shall provide development, test, and integration capacity to support the Mission and Program requirements on a non-interference basis with product generation and distribution processing.

ID: 5095
Discussion: Three days is the current storage capacity.

ID: 5096

3.5.8 Interface to other groupings

ID: 5097
Removed.

ID: 5098
The PG Grouping shall receive and process ancillary science data as necessary to generate data products within the PG Grouping.

ID: 5099
Discussion: It is expected that the PG Grouping product generation will require processing of data from one or more GOES, and other earth-based platforms as well as other science data (Model data, Forecast data, Grid format data, GRIB format data, Radar data, and Surface Data) to produce GOES products. The system is expected to accommodate the additional processing load as it becomes necessary during the system lifetime. Additional data sets and additional processing for blended products will occur through the NESDIS Infrastructure Interface of section 3.7 and with the merged processing discussed in section 3.7.2.

ID: 5100
Removed

ID: 5101
Removed

ID: 5102
Remove

ID: 5103
Remove

ID: 5104
The PG Grouping shall provide updated instrument calibration tables to the MM Grouping.

ID: 5105
Removed

ID: 5106
>Removed

ID: 5107
>Removed

ID: 5108
Discussion: All Level 1b data is expected in increments of source packets. Currently, there is no plan for buffering level 1b in the PG grouping. Any missing scans are reflected in the product. The processing into products takes place in source packets (or many source packets if required to properly re-project or sector the data.)

ID: 5109

3.5.8.1 Other Earth-based platform Data Interface(s)

ID: 5110

The PG Grouping shall ingest Sensor Data Records (SDRs) formatted as (**TBS**) from Ground Systems for NPOESS, METOP, NASA Satellites, NPP, and other satellites as necessary.

ID: 5111

Discussion: This is intended to address only those Ground Systems providing SDRs used in conjunction with GOES R series data to produce products synergistically.

ID: 5112
These SDRs shall be received by the PG Grouping ingest processing on the basis of data source, type, and band identifiers.

ID: 5113
Remove

ID: 5114
Remove

ID: 5115
Remove

ID: 5116
Discussion: All SDR data should be appropriately time-stamped.

ID: 5117

3.5.8.2 Other Science Data Interface(s)

ID: 5118
The PG Grouping shall ingest other science data formatted as (**TBS**) from, at a minimum, AWIPS, DAPS, and NCEP centers.

ID: 5119
Other science data shall be ingested by the PG Grouping processing on the basis of data source, type, and identifiers.

ID: 5120
Removed

ID: 5121
Removed

ID: 5122
Removed

ID: 5123
Discussion: All other science data is expected in increments appropriate to the data type and provided in a documented format with appropriate temporal information.

ID: 5124
Removed

ID: 5125
Removed

ID: 5126

3.5.8.3 NESDIS Enterprise Infrastructure Interface interface(s)

ID: 6457
The PG shall provide PG algorithms to the **NESDIS Enterprise Infrastructure Interface** functional grouping.
Discussion: This will consist of algorithm documentation as well as implementation software with full documentation. All versions of the algorithms will be archived.

ID: 5127
Removed

ID: 5128
Removed

ID: 5131
Removed

ID: 5133
The PG Grouping shall provide products formatted as, at a minimum (TBR), GIF, Text, BUFR, GRIB, Binary, JPEG, NetCDF, and McIDAS files or replacement files via the Distribution Grouping to the User Interface.

ID: 5134
Discussion: Currently, two classes of products are generated that encompass Level-1b, Level 2, and Level 3: those required to keep up with the GOES space view broadcast (i.e, ingest, process, and dissemination to end user must complete during the space viewing cycle plus whatever time increment before the next GOES view starts), and those that have to complete within some maximum time increment (usually this is a small number of additional minutes) from the receipt of the last dataset needed by the product. The former are termed Instrument Viewing Cycle "IVC" and the latter "Near-IVC".

ID: 6458

3.6   Product Distribution Functional Grouping

3.6.1 PD Component Architecture

The PD Grouping shall manage, develop, test, integrate, and place into operation the hardware and software system components for the maintenance of existing capability and the development of new capability.

Discussion: Multiple processing strings operating concurrently may require concurrent ingest of data received from the GL Segment Groupings or as time-delayed blocks. Some processing strings may require both entire sets of data and data extracted from single or multiple data sets. This could require file management services and buffering internal to the PD Grouping sized to meet both near-real-time and delayed transport of data.

3.6.1.1 Legacy and Concurrent Operations

The PD Grouping shall support configuration control, element and data flow monitoring and reporting, integration, test, and verification activities concurrent with PD Grouping primary data processing operations.

The PD Grouping shall operate concurrently with legacy operations with no operational disruption on fulfillment of any requirement.

Discussion: This transition legacy and concurrent operations will apply to backup operations, continuity of data flow and processing, product distribution, and ease of maintenance.

3.6.1.2 System Capability

The PD Grouping shall perform all Grouping functions, including those occurring simultaneously, with no interference or performance degradation of any Grouping functionality.

3.6.2 Product Distribution Capabilities

The PD grouping shall distribute Level 1b data to Government processing centers, described in Section 4.1 in real-time.

A test bed system for end-to-end testing of all components of the PD Grouping shall be developed and maintained. This test-bed capability shall be maintained after launch to facilitate testing and implementation of new and improved products and services.

ID: 5056
Systems for the distribution of products and services to all customers shall be developed. The distribution methods shall be a function of user requirements and capabilities, specifically relating to centralized versus localized product processing decisions.

Discussion: Communication links, regardless of their type, shall be capable of handling the volume of data expected for GOES R Series instrumentation as well as routing of the data to both Users and Data Centers for Archiving.

The PD Grouping shall transmit generated products (including Level 1b data) to user portals.

Discussion: The PD Grouping is expected to provide User distribution for the data and products within the data latency requirements. Data older than the short term (30 day archive) described elsewhere will be obtained through the Archive and Access functionality of the NESDIS Infrastructure Interface described in section 3.7 . The user portals currently include AWIPS SBN (via NWSTG), Miami NHC and TPC, Norman SPC, Kansas City AWC, Offutt AFB, Bowie and Camp Springs NCEP, NOAAPORT providers, and the NWSTG.

ID: 5132
The PD Grouping shall provide "push" and "pull" product distribution mechanisms, where pushing transmits data and information via an appropriate subscription to the Users and pulling permits selected access by the user, possibly on a non-regular basis

ID: 6039
The PD Grouping shall offer parsing functionality to minimize data loads for users only requiring portions of complete data sets.

Discussion: This may require data base management services with interactive access to data archives or even CCSDS protocols. Database management services include such as things as response to queries and enabling users to parse only the data required to satisfy their needs.

ID: 6459
The PD Grouping shall receive and log acknowledgments of product delivery and receipt to PD distribution points.

ID: 6460
Discussion: The PD functionality could be designed to be a "Point of Presence" for GOES-R satellite data. In this mode, users can acquire data electronically through pull services as soon as data is available to the PD functionality, or users can subscribe to push services from the PD. The parsing service can operate for both query pull/push services or for standing order subscription services. The MM and PG Grouping services can both provide data to the Archive and Access Functionality of the NESDIS Infrastructure Interface (Section 3.7) without delay as processed for distribution. Enabling the POP mode of operations will expand the availability of GOES-R data to all classes of users using untended electronic data exchange services. Currently NOAA uses the Federal Geophysical Data Committee (FGDC) standards for formatting descriptive metadata to support user queries. NOAA is currently adjusting these services to extend query services to better serve commercial search engines such as "Google" to better focus user queries for data.

ID: 6461
The PD Grouping shall transmit all products, associated metadata, and calibration coefficients to Data Centers via the NESDIS Infrastructure Interface.

ID: 6462

3.6.3 Interface to other groupings

ID: 6463
The PD Grouping shall receive and process data from other GL Segment groupings simultaneously.

ID: 6464
The PD Grouping shall receive and process data from other GL Segment groupings as defined in appropriate Interface Control Documents.

ID: 6465
3.6.3.1 Product Generation Interface

ID: 6466
The PD grouping shall transmit other science data used in and produced by PG processing to Data Centers via the NESDIS Infrastructure Interface.

3.6.3.2 User Interface

The PD Grouping shall provide products formatted as, at a minimum (TBR), GIF, Text, BUFR, GRIB, Binary, JPEG, NetCDF, and McIDAS files or replacement files as received from the PG grouping.

The PD grouping shall provide Mission data to Users.

ID: 6467

3.6.3.3 NESDIS Enterprise Infrastructure Interface interface(s)

***ID:* 6468**

The PD shall provide Product Generation algorithms to the NESDIS Enterprise Infrastructure Interface functional.
Discussion: This will consist of algorithm documentation as well as implementation software with full documentation. All versions of the algorithms will be archived.

ID: 5127
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ID: 5128
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ID: 5131
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ID: 5133
The PD Grouping shall provide products formatted as, at a minimum (TBR), GIF, Text, BUFR, GRIB, Binary, JPEG, NetCDF, and McIDAS files or replacement files to the Archive and Access functionality within the NESDIS Enterprise Infrastructure Interface.

ID: 6469

The PD Grouping shall deliver products to the NESDIS Enterprise Infrastructure Interface within time frames that allow the products to be made available for access within GOES R end-to-end latencies (**TBS**).

ID: 5134
Discussion: Currently, two classes of products are generated that encompass Level-1b, Level 2, and Level 3: those required to keep up with the GOES space view broadcast (i.e, ingest, process, and dissemination to end user must complete during the space viewing cycle plus whatever time increment before the next GOES view starts), and those that have to complete within some maximum time increment (usually this is a small number of additional minutes) from the receipt of the last dataset needed by the product. The former are termed Instrument Viewing Cycle "IVC" and the latter "Near-IVC".

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ID: 6470

3.7 NESDIS Infrastructure Interface

ID: 6471
NESDIS will supply the following existing structure that will interface with GOES-R. The NESDIS interface already exists in some form and will evolve over time. The NESDIS Infrastructure encompasses at least the following: the Archive and Access functionality and the NESDIS Merged Processing functionality. The Archive and Access Segment formerly discussed in the previous version of the MRD essentially have been incorporated here and will be met first by CLASS; if CLASS cannot meet the requirements below for any reason, the requirements will have to be met by another mechanism, as they are needed for GOES-R.

ID: 6472

The GOES-R system shall interface to the NESDIS Infrastructure.

ID: 6473

All NESDIS Infrastructure Interfaces to GOES-R, including hardware and software, shall be described in appropriate documentation, including Interface Control Documents (ICDs).

ID: 6474
All documentation for the NESDIS Infrastructure Interface to GOES-R shall be prepared in accordance with documentation standards that are subject to US Government approval.

ID: 6475
All documentation for the NESDIS Infrastructure Interface to GOES-R shall be prepared in accordance with documentation standards that are subject to US Government approval.

ID: 6476

3.7.1 Archive and Access

ID: 6478
Discussion:
The Archive and Access functionality is currently performed by the Comprehensive Large Array and Stewardship System (CLASS). This system exists and contains data from GOES and other observing systems, including POES and in the future NPOESS. A general discussion of class follows. The GOES-R needs on the far side of the interface are then discussed below, in light of the comments above.

ID: 6479

3.7.1.1 General CLASS

ID: 5166
In the GOES R era an upgraded Comprehensive Large Array-data Stewardship System (CLASS), or its follow-on, will be in place to handle the extensive types and volume of environmental data required to be archived and accessed. A more detailed description and a 5-year plan is available for CLASS. *
This system is a re-engineering and upgrade of current archive capabilities serving the National Data Centers (NCDC, NGDC, NODC). Data currently archived includes NWS NEXRAD, ASOS, radiosonde, climatic, and model data; NOS hydrographic data, bathymetric maps, and topographic maps; NMFS (**TBS**), OAR solar radiation, aircraft reports, wind profiler data, and geologic data; NOAA-NESDIS POES and GOES data; and DoD DMSP data. The volume of data in 2000 was 1,000 TB annually. The added requirements for archiving and providing access to NASA EOS, NPOESS NPP, METOP, and full NPOESS data in the 2005 - 2012 timeframe will increase the volume to 13,000 TB annually.

ID: 5167

The CLASS is developed to accommodate significant increases in data while allowing for more efficient and integrated capabilities among the data centers. The CLASS program maintains its own requirements documents in which the GOES R portions will need to be included. While the CLASS GOES ingest function needs to be able to handle the current 2.1 Mb/s GOES data rate, the CLASS designers are fully aware of the need for the ingest function to scale up to GOES-R data rates expected to be 150 Mb/s or more by 2012.

ID: 5168

3.7.1.1.1 CLASS Ingest and Archive Considerations

ID: 5169

The current plan is that CLASS will be a single software system operating at two distinct locations, one in the Washington, DC metropolitan area (currently Suitland, MD) and the other in Asheville, NC. Datasets will be ingested and archived in robotic storage (see the previous paragraph for storage estimates) at one location and immediately mirrored in robotic storage at the other location via telecommunications links. Each site will have failover capability (i.e., in the event of failure at one site, the other site will automatically take over) to continue ingest and distribution operations. An important component of access capability will be the telecommunications capacity between the CLASS sites (Suitland and Asheville) and the Internet. The NCDC in Asheville is acquiring an OC-3 connection that has a 155 Mbps bandwidth (for comparison a T-1 line has a bandwidth of 1.554 Mbps). Future data rates will require improved capabilities.

ID: 5170

3.7.1.1.2 CLASS Distribution Considerations

ID: 5171

CLASS will distribute data and products to a wide variety of users ranging from scientists doing weather and environmental research to school children doing homework to other interested parties wanting a satellite image of a recent storm in their area. Users will access the CLASS site via the Internet using a standard web browser. The system will enable Users to search for the data of interest based on source, instrument, time, and location and will provide browse images as a search aid. Future enhancement to CLASS will potentially enable more advanced search capabilities such as natural language processing, browse animations, and category searches, e.g., "tornados" or "clear days".

ID: 5172
While most data distribution is expected to be electronic, Users will be able to request media such as CD or tape, although media deliveries will have cost recovery requirements. Electronic delivery will typically be via "pull" FTP, whereby the CLASS system will notify the requester that the requested files are available at a specified FTP site and the user has a specific number of days in which to retrieve the files before they are purged.

ID: 5173

Users can also make arrangements for "push" FTP accounts, whereby the CLASS system will automatically attempt to push the requester's files to the requester's system as soon as the files have been retrieved. Furthermore, Users can establish arrangements for subscription service with either "push" or "pull" delivery, which identifies data of interest during data ingest and automatically stages the data for delivery to subscribers. Large orders (having a file sizes or numbers of files beyond certain established parameters) will be handled under "bulk order" processing which will process the requests in the background with a lower priority. Bulk orders can be delivered as multiple partial orders over a period of days, weeks or months, depending on the size of the order, until the full order has been completed. Policies will be established regarding what monetary charges, if any, will apply to specific

datasets, specific customers, etc. Some of the factors that drive the bulk order concept are how long does it take to retrieve the files of interest both in 2002 and in the 2012 timeframe, how much processing must be done with the files and how much bandwidth is needed to transmit the delivery order (which may be a subset of the files of interest). Other potential factors establishing priority might be who the customer is (e.g., government customer vs. commercial vs. academic) or whether or not the customer is paying for the data.

ID: 5174

3.7.1.1.3 CLASS Dataset and Format Considerations

ID: 5175
GOES data to be archived includes Level 1b and derived data products. CLASS will allow users to subset the GOES data, e.g., geographic sub-setting within user-specified spatial, spectral, or temporal limits or a reduced resolution data set using sub-sampling techniques. CLASS will also allow the User to specify alternative data formats, e.g., GVAR (or future GRB), NetCDF, or McIDAS area files. Because GOES data products are much smaller in volume relative to the GOES data, they will be archived and distributed in their native formats. However, the system will also provide reference information regarding algorithms used for generating the products, thereby enabling future users to regenerate the products or enhance the algorithms. In cases where GOES data products comprise other data besides GOES data, product regeneration will, of course, be dependent on the availability of the other non-GOES data.

ID: 5189

3.7.1.2 General Archive and Access Functionality

ID: 5190

The AA functionality shall manage, schedule, and control data processing and resources within the **NESDIS Enterprise Infrastructure Interface**.

ID: 5191

The AA functionality shall ingest and preprocess received data in accordance with each data format.

ID: 5192
The AA functionality ingest and preprocessing shall include, at a minimum, signal processing, decompression and decryption as required, and data routing.

ID: 5193

The AA functionality shall ingest, process, and store all data required to produce the full complement of GOES R Series products as projected for FOC.

ID: 5194
The AA functionality System Elements shall be expandable to permit (TBD) growth in storage and processing capacity over the life of the GOES R Series.

ID: 6043
The AA functionality shall provide the following monitoring and data quality functions:
* display data and images from the GRB data.
* perform radiometric data quality monitoring.
* perform INR data quality monitoring to include landmark verification.
* derive predictive orbit and attitude data.

ID: 6044
Discussion: The monitoring and data quality function(s) are intended to support not only product QA activities but also support troubleshooting of product anomalies occurring in the Ground System Segment. Toward this end, it is expected that these functions will be replicated in all the Ground System Groupings.

ID: 6480

The AA functionality shall allow received products and data to be available for access within GOES R end-to-end latencies (**TBS**).

ID: 5195

3.7.1.2.1 Archive and Access Legacy and Concurrent Operations

ID: 5196
The AA functionality shall support configuration control, element and data flow monitoring and reporting, integration, test, and verification activities concurrent with AAS primary functional operations.

ID: 5197
The AA functionality shall include the GOES R Series with no operational disruption on fulfillment of any requirements.

ID: 5198

Discussion: This transition shall apply to backup operations, continuity of data flow and processing, access request processing, data and information distribution, and ease of maintenance.

ID: 5199

3.7.1.2.2 Archive and Access System Capability

ID: 5200
The AA functionality shall fully satisfy all required functions, including those occurring simultaneously, with no interference or performance degradation of any Archive and Access (AA) functionality.

ID: 5201
Removed

ID: 5202
Discussion: Data distribution can be accomplished using a different segment/grouping if it is determined through concept studies and technology and risk trade analyses that this is more efficient.

ID: 5203
The AA functionality shall provide archival storage for, at a minimum, the following data:

ID: 5204
    a. All received SDRs

ID: 5205

    b. Level 1b, Level 2 and any higher level (i.e. level 3) Products

ID: 5206
    c. Metadata

ID: 5207
    d. Other science data being used in PG Processing

ID: 5208
    e. Other information

ID: 5209

The AA functionality shall provide bandwidth sufficient to accommodate interfaces to all NESDIS Enterprise Infrastructure Interface networks.

ID: 5210

The AA functionality shall provide processing capacity in the System Elements to support the mission within latency requirements.

ID: 5211

The AA functionality shall provide development, test, and integration capacity to support the Mission and Program requirements on a non-interference basis with product generation and distribution processing.

ID: 5232

The AA functionality shall transmit data and information via an appropriate subscription to Users, who are described in section 4.1.

ID: 5234

The AA functionality shall receive and log acknowledgments of product delivery and receipt to AA distribution points.

ID: 5235

The AA functionality shall process and preserve product formats including, at a minimum (TBR), GIF, Text, BUFR, GRIB, Binary, JPEG, and McIDAS files or replacement files.

3.7.1.3 Archive and Access interfaces to GOES-R

ID: 5213

3.7.1.3.1 Archive and Access interfaces needed for GOES-R User Interface

ID: 5214

The AA functionality shall receive and process data, requests, and distribution from (**TBS**) ports simultaneously to support users.

ID: 5215

The AA functionality shall receive and process requests based on User and data subscription properties including, at a minimum, priority, viewing privileges, and data release constraints.

ID: 5216
The AA functionality shall authenticate all data requests and deny data requests from designated Users when directed by appropriate authority.

ID: 5217

ID: 5218

3.7.1.3.2 Archive and Access interfaces needed for GOES-R PD functional grouping

ID: 5219
The AA functionality shall receive Level 1b data and associated metadata from PD.

ID: 6481
The AA functionality shall receive Level 2 and Level 2+ product data and associated metadata from PD

ID: 6482
The AA functionality shall receive algorithm documentation and software from PD.

ID: 5220
The Level 1b data and metadata shall be received in real-time in source packets.

ID: 5221
The AA functionality shall archive Level 1b data and metadata and make them available for retrieval within (**TBD**) time frame.

ID: 5222
The AA functionality shall generate and transmit reports to PD that contain, as a minimum:

ID: 5223
        summary of Level 1b data and metadata received

ID: 6483

summary of product data received

ID: 6484
summary of algorithm data and software received

ID: 5224
summary of link and data quality

ID: 5225
*Discussion***:** All Level 1b data is expected in increments of source packets. Currently, there is no plan for buffering level 1b.

ID: 6484
The AA functionality shall report statistics for product delivery for GOES-R as requested by NOAA.

ID: 6484

3.7.2 Merged Processing

ID: 6485
The Merged Processing functionality will grow for the GOES-R timeframe. By the GOES-R timeframe data from other observing systems including non-GOES GEO satellites and LEO satellites such as those in NPOESS will be used to make operational merged or "blended" products. GOES-R products that utilize multiple instruments that are part of the GOES-R series are still considered GOES-R products, not merged products and will be made by GOES-R Ground Segment PD functional grouping. The small number of GOES-R products that require inputs from either NWP prediction, ASOS, radiosondes, and Doppler radar under clouds will also be made by GOES-R Ground Segment PD functional grouping. The GOES-R detailed requirements for the interface to the GOES-R timeframe system are TBS.

GOES-R Product	Additional Data needed for GOES-R product
Cloud Base Height: CONUS, Hemis, and Meso.	ASOS over CONUS, altimeters, radiosondes, NWP
Cloud Layers Heights and Thicknesses: CONUS, Hemis, and Meso	ASOS over CONUS, altimeters, radiosondes, NWP
Cloud Top Pressure: CONUS, Hemis, and Meso.	Radiosondes, NWP
Imagery: All weather: Day/Night Hemis,	Until Microwave is present, ASOS over CONUS, altimeters, radiosondes, NWP
Turbulence: Hemis and Meso:	ASOS over CONUS, altimeters, radiosondes, NWP
Visibility: Coastal and Hemispheric	ASOS over CONUS, altimeters, radiosondes, NWP
Rainfall Potential:	Until Microwave is present, ASOS over CONUS, altimeters, radiosondes, NWP, and doppler radar over CONUS.

Rainfall Rate / Quant. Precip. Estimate   Doppler radar useful under clouds
Pressure Profile: Mesoscale   Radiosonde, NWP models
Downward Longwave Radiation: Surface   ASOS over CONUS, altimeters, radiosondes, NWP
Microburst winds: Radiosondes

ID 5236

4.0 User Interface Segment

ID: 5231

4.1 User Interface(s)

ID: 6486
There will be many users for GOES-R data. There are prime users, which are portions of NOAA, who currently make algorithms and products for access, within the product latency, for their own users outside of NOAA. The product requirement of GOES-R listed in Section 1.4.7 were collected from groups inside NOAA who are responsible for reporting the needs of their respective users. Collectively both of these groups are called users.

ID: 6487
There are also two classes of data usage - operational and retrospective. Most users performing operational data usage requiring real-time data delivery for forecast and warning services will receive their GOES-R data directly from the PD Grouping or from the GRB. There are other users performing near-real-time operational who could query the GOES-R database to "pull" data in different temporal, spatial, or spectral forms depending on a particular immediate needs. The PD functionality will also support those working with GOES data in this way. The retrospective users will also query the GOES-R database to "pull" data in different temporal, spatial, or spectral forms depending on a particular long-term needs. The AA functionality of the NESDIS Infrastructure Interface would continue to service the retrospective users as is done today.

ID: 6488
Real time and near-real time users shall be (TBS).

ID: 5233
 Users shall include, at a minimum, AWIPS SBN (via NWSTG), Miami NHC and TPC, Norman SPC, Kansas City AWC, Offutt AFB, Bowie and Camp Springs NCEP, NOAAPORT providers, and the NWSTG.

ID: 6489
Retrospective users shall be (TBS).

ID: 6490

4.2 User Interface Needs

ID: 6491
GOES-R system shall make data available to the users portals.

Discussion: Making data available to the users portals may occur by a number of means including the rebroadcast of the partial data set of the GRB as described in section 2.10.8.3.1 and options for GFUL (described in section 3.5.7.4 on GOES R Series Level 1b Data) ranging from push and pull capability to GFUL distribution. Push implies sending data to the user on a subscription basis, describing what will be delivered to the user on a regular basis. Pull means users request data, not necessarily on a regular basis.

ID: 6492
GOES-R User Interface needs for a push/pull capability for GOES-R data shall be supported to address large volume users and smaller volume users.

ID: 6493
Software required to permit interface with the GOES-R data shall be generated and maintained to meet the User interface needs.

ID: 6494
The User Interface shall process product formats including, at a minimum (TBR), GIF, Text, BUFR, GRIB, Binary, JPEG, NetCDF, and McIDAS files or their replacement file formats.
Discussion: This does not imply that all data formats envisioned by the user will be supported. However, common formats and replacement file formats for the typical formats listed above will be supported.

ID: 6495
The User interface need for documentation of the data formats and interface software shall be supported through documentation of data formats and interface software.

ID: 6496
The User interface need for configuration management of the data formats and interface software shall be supported through documentation of data formats and interface software.

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4.3.3 Education and Training

ID: 5259
Discussion: Space-based remote sensing is going through a major increase in observing capability over the next decade. One major challenge is making sure that managers and users are aware of the latest advances in space-based observing capabilities. The goal is to transfer research results based on atmospheric remote sensing data into NWS operations. There is also the opportunity to expand public outreach.

ID: 5260

4.3.1. Expand Training through VISIT Program

ID: 5261
Discussion: The GOES Users subcommittee on Training, Education and Outreach proposes that the impending shortfall in providing training and education resources be addressed. This need for education and training can be met by establishing expanded satellite training as part of the Virtual Institute for Satellite Integration Training (VISIT) program. The mission of the VISIT program is to accelerate the transfer of research results based on environmental remote sensing data into NOAA's operations using distance education techniques. NOAA's National Environmental Satellite Data and Information Service and National Weather Service cosponsor the VISIT program. The primary distance training tool used by VISIT is synchronous teletraining.

ID: 5262

4.3.2 Proposal for Satellite (HydroMeteorology) SHyMET Course

ID: 5263

Discussion: The GOES Users Committee has proposed that the satellite training activities be expanded to provide comprehensive distance learning courses that produce satellite experts in all parts of NOAA's operational programs. The teletraining conducted by the VISIT program (<http://www.cira.colostate.edu/ramm/visit/visithome.asp>) will be one of the training components used for these comprehensive earth observing satellite courses. The training courses will be incorporated into the Department of Defense (DOD) programs and will be included in the World Meteorological Organization's Virtual Laboratory for Education and Training in Satellite Meteorology.

ID: 5264

The goal of the expanded NOAA satellite training program is to develop satellite hydrometeorology experts in support of NOAA and DoD operations.

ID: 5265

The initial activity in fiscal year 2003 is to prepare a detailed proposal for an expanded satellite training course. This enhanced training completes the end-to-end GOES program by ensuring that the users will be prepared for all the new data and products. A major action for fiscal year 2003 is to get initial NOAA approval and funding to begin planning for the Satellite HydroMeteorology (SHyMet) Course

ID: 5266

The new satellite-training program will use a blended training format similar to that employed by NOAA's Distance Learning Operations Course (DLOC) for radar. DLOC runs for 8 to 10 weeks of distance training followed by a 4-day residence workshop. DLOC is run once per year in the autumn for 70 to 110 NOAA students. Upon successful completion of DLOC, the students are certified to use the radar data and products as part of NOAA's NWS severe weather warning program.

ID: 5267

The satellite-training course shall be given to 60/100 NOAA students per year. The goal is to have at least one environmental satellite expert in each NOAA operations office.

ID: 5268

A major issue is how to provide the motivation to NOAA's operational staff for taking the time to complete an intensive satellite-training program. The proposal is to provide college credit through NOAA's cooperative institutes as part of the VISIT program.

ID: 5269

The final action is to complete development of new Satellite HydroMeteorology (**SHyMet**) Course as soon as funding and resources are available. Initial course offerings will focus on new data and products available from new satellite instruments available from platforms such as NASA's TERRA and AQUA (with MODIS and AIRS), METOPS (AIRS), NPP, and GIFTS/IOMI.

ID: 5270

4.3.3 Public Outreach Public outreach performed by NOAA.

ID: 5271

Discussion: Public outreach is an important activity because it shows the public the source of the weather data, while generating interest in meteorology, atmospheric research, and space weather research, oceanography, and environmental monitoring. Training courses that are generated for NOAA employees (see section above) could be easily translated to the general public for any of several uses including NOAA web pages, science museum displays, or visitor centers or lobby kiosks. Classroom lessons that could be downloaded from NOAA pages or web pages catering to teachers would clearly be useful for everyday teaching or for special guest teachers and parents.

ID: 5275

4.4.4 Interface to other segments

ID: 5276
Data products from both the Ground Segment and specifically from the PG Grouping and interesting cases from the AA functionality shall be used in remote teletraining.

ID: 5277
Data products from both the Ground Segment and specifically from PG Grouping and interesting cases from the AA functionality shall be used in public outreach.

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Abbreviations

ID:
5279
AA   Archive and Access

ID:
6580
A&O   Acquisition and Operations

ID:
5280
ABI   Advanced Baseline Imager

ID:
5281
ABS   Formerly the Advanced Baseline Sounder

ID:
5282
ATS   Absolute Time Sequence

ID:
5283
AWC   Aviation Weather Center (located in Kansas City)

ID:
5284
AWIPS   Advanced Weather Interactive Processing System

ID:
5285
BUCDAS Backup Command and Data Acquisition Station

ID:
5286
CCSDS   Consultative Committee for Space Data Systems

ID:
5287
CDA   Command and Data Acquisition

ID:
5288
CDAS Command and Data Acquisition Station

ID:
5289
COTS Commercial Off-the-Shelf

ID:
5290
CVCDU   Coded Virtual Channel Data Unit

ID:
5291
CW   Shelf and Coastal Waters (portion of HES)

ID:
5292
DAPS Data Collection Platform (DCP) Automated Processing System

ID:
5293
DCPI   Data Collection Platform Interrogation

ID:
5294
DCPR Data Collection Platform Report

ID:
5295
DS   Disk Sounding (portion of HES)

ID:
5296
DOEE Detector Optics Ensquared Energy

ID:
5297
EEZ   Exclusive Economic Zone

ID:

5298
EMWIN   Emergency Managers Weather Information Network

ID:
5299
FCDAS   Fairbanks Command and Data Acquisition Station

ID:
5300
FEC   Forward Error Correction

ID:
5301
FOC   Final Operational Capability

ID:
5302
GFUL   Complete set of Level 1b data

ID:
5303
GEO   Geosynchronous Earth Orbit

ID:
5304
GS   Ground Segment

ID:
5305
GOES   Geosynchronous Operational Environmental Satellite

ID:
5306
GRB   GOES Rebroadcast (subset of Level 1b data)

ID:
5307
GVAR   Goes Variable Format Data

ID:
5308
HES   Hyperspectral Environmental Suite

ID:
5309
I & T   Integration and Test

ID:
5310
INR   Image Navigation and Registration

ID:
5311
IOC   Initial Operational Capability

ID:
5312
IVC   Instrument Viewing Cycle

ID:
5313
L   Land (portion of HES)

ID:
5314
LEO   Low Earth Orbit

ID:
5315
LRIT   Low Rate Information Transmission

ID:
5316
LZA   Local Zenith Angle

ID:
5317
METOP   Meteorological Operational (satellite)

ID:
6578
MM   Mission Management

ID:
5318
MRD   Mission Requirement Document

ID:
5319
MTBF Mean Time Between Failure (of a system/component)

ID:

6342

MTTF Mean Time to Failure

ID:
6344

MTTR Mean Time to Repair

ID:
5320

NASCOM NASA Communication Network

ID:
5321

NCEP National Center for Environmental Prediction

ID:
5322

Near-IVC Instrument Viewing Cycle plus a small amount of time

ID:
5323

NEdN Noise Equivalent Radiance Error

ID:
5324

NEdT Noise Equivalent Temperature Error

ID:
5325

NHC National Hurricane Center (located in Miami, FL)

ID:
5326

NOAA National Oceanic and Atmospheric Administration

ID:
5327

NWS National Weather Service

ID:
5328

NPOESS National Polar-orbiting Operational Environmental Satellite System

ID:
5329

NPP NPOESS Preparatory Program

ID:
5330
NWSTG   National Weather Service Telecommunications Gateway

ID:
5331
O & M   Operations and Maintenance

ID:
5332
OO   Open Ocean (portion of HES)

ID:
5333
PGD   Product Generation

ID:
5334
PGDS Product Distribution

ID:
6579
Preliminary Design and Risk Reduction

ID:
5335
RDR   Raw Data Record

ID:
5336
RF   Radio Frequency(ies)

ID:
5337
RTS   Relative Time Sequence

ID:
5338
SARSAT Search and Rescue Satellite Aided Tracking

ID:
5339
SBN   Satellite Broadcast Network

ID:

5340
      SD   Sensor Data

ID:
5341
SDR   Sensor Data Record

ID:
5342
SEC   Space Environment Center

ID:
5343
SEM   Space Environment Monitor

ID:
5344
SOCC Satellite Operations Control Center

ID:
5345
SOH   State of Health

ID:
5346
SPC   Storm Prediction Center (located in Norman OK)

ID:
5347
SXI   Solar X-Ray Imager

ID:
5348
SSP   Satellite Sub-Point

ID:
5349
SW/M Severe Weather / Mesoscale (portion of HES)

ID:
5350
TBD   To Be Determined

ID:
5351
TBR   To Be Reviewed by the government and the contractor

ID:
5352
TBS   To be supplied by the government during the course of the contract.

ID:
5353
TPC   Tropical Prediction Center (located in Miami, FL)

ID:
5354
WCDAS   Wallops Command and Data Acquisition Station

ID:
5355

Appendix A: Detailed Requirements from the GPRD-1

ID:
5356
The compressed format of the appendix page required that the users in the table below, namely the offices inside NOAA, are listed with abbreviated forms of their names. In this appendix, Threshold is abbreviated with T and Objective (similar to goal) is abbreviated with O. Section 2.11.3 discusses any shortfalls in meeting NOAA's needs as described in the GPRD-1. That section also includes a discussion of any variation between the text of the GPRD-1 requirement and the planned implementation, and the justification.

ID:
5357
(NOTE: The GPRD-1 was signed in June 2004. The tables will be posted with the document and will be called Appendix A.)

ID:
5358

Appendix B: Radio Frequency Allocation Status

ID:
6317
NESDIS will update this table and its position on RF availability for the final MRD-2B.

ID:
5359

November 22, 2004

NESDIS POSITION

Dr. Dave McGinnis
NESDIS RF Manager

Mr. Roger Heymann
GOES-R Communications Engineer

GOES-R ERA RF SPECTRUM AVAILABILITY
(SUBJECT TO LIMITATIONS FOUND IN COMMENTS and NOTES)

Option #	Sensor DOWNLINK to Wallops (prime), Fairbank (back-up), GSFC (back-up)	NESDIS Comments
#1	7450-7550 MHz	Stage 1 petition filed by NESDIS with NTIA. Use of this spectrum not recommended by NTIA due to electromagnetic compatibility and sharing issues between proposed GOES earth station receivers and other authorized users of the band. The main concern is protection of the GOES receivers from Government terrestrial fixed transmitters and coordination with military fixed satellites to avoid harmful interference from GOES into the military satellites and their earth receivers. Coordination with military spectrum office (DISA) continuing. In order to protect the terrestrial services, the power flux-density limits of TABLE **21-4** of the Radio Regulations need to be met, i.e. between –152 and –142 dB(W/m^2) per 4 kHz bandwidth, depending on angle of arrival.
#2	8215-8400 MHz X-band	Stage 1 petition filed by NESDIS with NTIA. Use of this spectrum requires a small satellite separation between DOD DSCS at 135°W and GOES, as such, NOAA investigating relocating to 137°W. This sharing situation is between the GOES satellite transmitter and the DSCS satellite receiver. Analysis completed by Aerospace

		for NOAA indicates that a 2º separation between GOES and DSCS satellites should be sufficient to avoid harmful interference. Per NTIA, NOAA coordination with DOD critical. Also per NTIA NOAA coordination with Fixed Sat. Ser. and Earth Exploration Satellite Service (EESS), NASA EESS, DOC EESS, non-gov't EESS space systems and gov't. Government and non-Government non-geostationary EESS networks operate in the band 8025-8400 MHz. An analysis will be needed to determine the sharing compatibility between GSO EESS and NGSO EESS networks. NASA concerned about adjacent RFI from 8025-8400 MHz users into its Goldstone receiving earth station operating in the space research service (deep space)in the band 8400-8450 MHz; this suggests a guard band is needed. Further, ITU-R Recommendation SA.1157 states maximum interference power levels to earth-station receivers: PFD (-255.1 dB(W/m^2·Hz)) and PSD (-220.9 dB(W/Hz)) 8400MHz. This limit would have to be met at the Goldstone earth station. In order to protect the terrestrial services, the power flux-density limits of TABLE **21-4** of the Radio Regulations need to be met, i.e. between –150 and –140 dB(W/m^2) per 4 kHz bandwidth, depending on angle of arrival.
#3	8025-8175 MHz X-band	Stage 1 petition filed with NTIA. Use of this spectrum requires a small satellite separation between DOD DSCS at 135°W and GOES, as such NOAA investigating relocating to 137°W. This sharing situation is between the GOES satellite transmitter and the DSCS satellite receiver. Analysis completed by Aerospace for NOAA indicates that a 2º separation between GOES and DSCS satellites should be sufficient to avoid harmful interference. Per NTIA, NOAA coordination with DOD critical. Also per NTIA, NOAA coordination required with FSS and EESS, NASA EESS, DOC EESS, non gov't EESS space systems and gov't. Government and non-Government non-geostationary EESS networks operate in the band 8025-8400 MHz. An analysis will be needed to determine the sharing compatibility between GSO EESS and NGSO EESS networks. NASA concerned about RFI from 8025-8400 MHz users into deep space research network, Goldstone earth station, at 8400-8450 MHz. Further, ITU recommended PFD and PSD interference limits must be met above 8400MHz,see #1 above. In order to protect the terrestrial services, the power flux-density limits of TABLE **21-4** of the Radio Regulations need to be met, see #2 above.
#4	18.1-18.3 GHz Ku-band	Stage 1 petition filed with NTIA. NESDIS pursuing X band with higher priority. On advice of NTIA, to be considered if NESDIS is unsuccessful in obtaining access to 8 GHz spectra. Per NTIA, technology and rain fade issues have to be considered. NTIA has indicated recommended coordination with non-government terrestrial systems in band within a to-be-determined distance of

		the GOES receiving earth station(s). In order to protect the terrestrial services, the power flux-density limits of TABLE **21-4** of the Radio Regulations need to be met, i.e. between -115 and -105 dB(W/m^2) per 1 MHz bandwidth, depending on angle of arrival.
#5	25.25-27.0 MHz Ka-band	On advice of NTIA, to be considered if NESDIS is unsuccessful in obtaining access to 8 GHz spectra. Per NTIA, technology and rain fade issues have to be considered. NTIA has indicated recommended coordination. Within US, government would be primary spectrum user. New band allocated to EESS. In order to protect the terrestrial services, the power flux-density limits of TABLE **21-4** of the Radio Regulations need to be met, i.e. between -115 and -105 dB(W/m^2) per 1 MHz bandwidth, depending on angle of arrival..

	Processed Data UPLINK to GOES from CDA station(s)	Comments
#1	7190-7235 MHz X-band	NESDIS has not yet submitted a Stage 1 petition to NTIA. Will ask for 12 MHz BW, only. Concern with deep space network, informal discussions have been initiated between NOAA and NASA, and are ongoing. No issue with DOD and thus no issue with DSCS and GOES satellite separation at 135°W. NESDIS preferred option. The band is not currently allocated to the EESS and may require either a waiver or a modification to the national allocation table. Expect an unfavorable finding from ITU for station classes EW (EESS space station) and EM (metsat space station).
#2	8175-8215 MHz X-band	Stage 1 petition filed with NTIA. This requires maximum separation between GOES at 135°W and DSCS at 135°W. Amount of separation under study by Aerospace Corp., but greater than that required for either 8025-8175 or 8215-8400 MHz downlink. [Note: Roger, doesn't Aerospace analysis indicate necessary separation?] Per NTIA, NOAA coordination with DOD critical. NASA concerned about adjacent RFI from 8025-8400 MHz users into its deep space research network at Goldstone in the band 8400-8450 MHz. Discussions on both issues are currently ongoing with appropriate agencies.
#3	2025-2035 MHz S-band	Current GOES S-band uplink allocation protected for 3 CDA stations via footnote US222. Per footnote US346, except for that provided by US222, use of the 2025-2110 MHz band requires coordination with the Television Broadcast Auxiliary Service, the Cable Television Relay

		Service or the Local Televisiosn Transmission Service, in order no to constrain their deployment.

	Global Processed DOWNLINK data stream from GOES "Globally"	Comments
#1	1683-1698 MHz L-band	1683-1695 MHz for high resolution GRB data is available. 1695-1698 MHz for other broadcast downlinks. CDA T&C downlink can be located in 1670-1675 MHz band. MOU between NPOES and GOES, signed in February 2004, expands GOES L-band spectrum by an additional 3 MHz to 1698 MHz. ITU maximum PFD requirements for the radio astronomy band below 1670 MHz are quite strict and must be met. In order to protect the terrestrial services, the power flux-density limits of TABLE **21-4** of the Radio Regulations need to be considered; due to the lack of terrestrial services operating in the US, these limits may be able to be waived. There is also a power flux density limit to protect Metaids (radiosondes), but this may be waived as well since it has been shown that Metaids and Metsats cannot share spectrum.

Notes:
#1. Guard bands required relative to IPO (NPOESS) use above 1698 MHz, and NESDIS (GOES) use below 1698 MHz to avoid RFI.
2. NOAA envisions a spec requiring the use of SRRC filters to allow NOAA to get the BW authorization necessary. NOAA requires out-of-band filtering.
#3. NOAA envisions a spec for directional antenna focused on the CDA stations, which NOAA believes is necessary to get its authorization. Wallops is the prime NESDIS CDA station. NASA GSFC is the GOES 75ºW backup CDA station. Fairbanks is the 135°/137°W backup CDA station.
#4. NTIA oversees use of RF spectrum by all federal agencies.
#5. Earth Exploration Satellite-Service (EESS) - a radio communication payload services between earth stations and one or more space stations. Per ITU definition, Metsats are a subset of EESS used for meteorological purposes.
#6. ITU PFD limits for EESS and Metsat services must be met.
#7. NESDIS is working to obtain operational X-band approval. If this fails it will attempt to obtain Ku (18.1-18.3 GHz) and/or Ka (25.5-27 GHz) operational approval.

Appendix C: Radiance values for the HES (SEPARATE DOCUMENT DUE TO LENGTH)

ID:
5360
The radiance appendix mentioned in Section (2.10.2) 3.B.2.g is a separate document that is very long and thus is provided as a separate document. Coastal, ocean, and land values were updated to NASA in August 2004.